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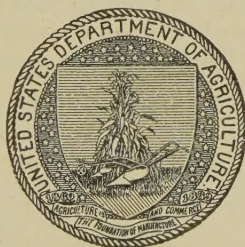
ANNUAL REPORTS
OF THE
DEPARTMENT OF
AGRICULTURE

FOR THE YEAR ENDED JUNE 30,

1916.

REPORT OF THE
SECRETARY OF AGRICULTURE.

REPORTS OF CHIEFS.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1917.

7630.6
225
v. 70

[CHAPTER 23, Stat. L., 1895.]

[AN ACT Providing for the public printing and binding and the distribution of public documents.]

* * * * *

Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part One, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; Part Two, which shall contain such reports from the different Bureaus and Divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of Part One, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of Part Two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.

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REPORT OF THE SECRETARY OF AGRICULTURE.

REPORT OF THE SECRETARY OF AGRICULTURE

WASHINGTON, D. C., *November 15, 1916.*

SIR: The half of agriculture embracing the marketing of farm products, rural finance, and rural organization has strikingly occupied attention during the last three and one-half years. Before 1913 little systematic thought had been devoted to it and there did not exist, either in the States or in the Nation, effective instrumentalities to furnish assistance and guidance to farmers in this field, nor had the laws necessary to remedy abuses and control unfavorable conditions been formulated or enacted. In view of the complexity and novelty of the problems, the accomplishments—legislative and administrative—have been notable and significant. This seems an opportune time to summarize them.

Early in 1913 a program for the ensuing four years was developed. This program in large measure has been executed. In the first place provision was made promptly for the creation of the Office of Markets and Rural Organization. Beginning with a modest sum, the appropriations for this office, including those for enforcing new laws to promote better marketing, have increased to \$1,242,000. Quickly an effective organization was developed and today the Nation possesses in this department the largest and best trained and supported staff of experts dealing with the distribution of agricultural commodities and rural organization to be found anywhere in the world. It is engaged in investigating all the larger and more difficult problems confronting farmers in this new field.

The matter of establishing standards for staple agricultural products, of supervising the inspection of grains shipped in interstate and foreign commerce and the operations of cotton futures exchanges, of devising financial machinery suited to the needs of the rural population, of developing a better system of warehouses for agricultural products, and of Federal aid in highway construction, received careful attention. The result was the enactment of a number of highly

important laws—the Cotton Futures Act, the United States Grain Standards Act, the United States Warehouse Act, the Federal Farm Loan Act, and the Federal Aid Road Act.

Under the Cotton Futures Act, which was enacted on August 18, 1914, and reenacted with amendments in the Agricultural Appropriation Act for the fiscal year 1917, standards for cotton have been established, the operations of the futures exchanges have been supervised, and cotton trading has been placed on a sounder basis.

The United States Grain Standards Act, which is included in the Agricultural Appropriation Act for the fiscal year 1917, will bring about uniformity in grading, enable the farmer to obtain a fairer price for his product and to improve its quality, and prevent or diminish materially the shipment of adulterated grain.

The United States Warehouse Act, also included in the Agricultural Appropriation Act for 1917, authorizes the Department of Agriculture to license bonded warehouses which handle certain agricultural products. It will make possible the issuance of reliable and easily negotiable warehouse receipts, promote the better storing of farm products, and encourage the standardizing of storages and of marketing processes.

The Federal Farm Loan Act was approved on July 17, 1916. It creates a banking system which will reach intimately into the rural districts, operate on terms suited to the farmer's needs under sympathetic management, introduce business methods into farm finance, bring order out of chaos, reduce the cost of handling farm loans, place upon the market mortgages which will be a safe investment for private funds, attract into agricultural operations a fair share of the capital of the Nation, and lead to a reduction of interest.

A provision in the Federal Reserve Act, which was approved on December 23, 1913, authorized national banks to lend money on farm mortgages and recognized the peculiar needs of the farmer by giving his paper a maturity period of six months.

The Federal Aid Road Act, approved July 11, 1916, provides for cooperation between the Federal Government and the States in the construction of rural post roads and of roads and trails within or partly within the National Forests. This measure will conduce to the establishment of a more effective highway machinery in each State, strongly influence the development of good road building along right lines, stimulate larger production and better marketing, pro-

mote a fuller and more attractive rural life, add greatly to the convenience and economic welfare of all the people, and strengthen the National foundations.

BUREAU OF MARKETS.

I have recommended in the estimates for the fiscal year 1918 that the name of the Office of Markets and Rural Organization be changed to "Bureau of Markets." The importance of the work and the size of the organization fully justify this change, and there is widespread sentiment throughout the country in favor of it. It is in the interest of simplicity and convenience and will give the organization a title by which it is already generally known.

The work of the Office of Markets and Rural Organization has developed very rapidly, and some notable results have been secured. Definite assistance has been rendered to the fruit interests of the States of Oregon, Washington; Idaho, and Montana. An organization composed of cooperative associations, corporations operating for the producers, and individual growers was formed during the past year. The purpose of the organization is to secure broader distribution through the establishment of uniform grades and marketing methods. Through it the fruit industry of the Northwestern States should be placed upon a more efficient business basis. It comprises 65 per cent of the northwestern fruit industry, representing an investment of \$150,000,000, and supporting approximately 20,000 growers. This is probably the most important single activity in forming cooperative organizations that has yet been undertaken by the department.

Well-tested systems of accounts and records for primary grain elevators, for live-stock shipping associations, and for cooperative stores have been issued. Systems for country creameries and cotton warehouses have been devised and are being tested under commercial conditions. Systems perfected by the department for farmers' cooperative elevators and for fruit and produce associations already are in extensive use. A plan for adapting farmers' grain-elevator companies to the patronage dividend basis has been worked out and published.

The issuance of monthly cold-storage reports on apples has been continued, and the work has been extended to include butter, eggs, and cheese. These reports show the cold-storage holdings through-

out the country, and include a comparison of the holdings of the current year with those of the previous year. In cooperation with carriers, extensive investigations of the economic waste of foodstuffs in transit have been conducted. The object of these investigations is to secure better cooperation between shippers and carriers and greater efficiency in methods of handling, with a view to eliminate, or at least greatly to reduce, the present waste.

MARKETING LIVE STOCK AND MEATS.

A systematic survey of centralized live-stock markets, begun during 1915, has been extended to cover practically all the large stockyard centers. Arrangements have been made with 58 stockyard companies to secure monthly reports of live-stock receipts and shipments. A uniform system of market records has been adopted, at the instance of the department, by a number of the yards. Twenty-six companies are reporting stocker and feeder shipments separately, in accordance with a form prepared by the Office of Markets and Rural Organization.

An investigation of the organization and conduct of cooperative live-stock shipping associations, begun during 1915, has been completed and the results published. The directory of these associations now includes 485 organizations, aside from 440 other agricultural associations which ship live stock as a branch of their business. The farmers' cooperative packing-house movement was studied and a press bulletin on the subject was issued.

A conference relative to the marketing of live stock and meats was held at Chicago November 15 and 16, 1915, for the purpose of "ascertaining the essential facts pertaining to the industry with a view to bring about more stable marketing conditions, more efficient methods, closer cooperation, and a better understanding among all the interests connected with the industry." Representatives of all the National organizations and of other interests concerned with the live-stock and meat industry participated in the meeting. The proceedings were published as House Document No. 855, Sixty-fourth Congress, first session.

Methods and costs of marketing live stock and meats in the United States were investigated. Extensive schedules were sent to 10,500 correspondents of the Bureau of Crop Estimates. A sum-

mary and discussion of the returns, together with data on economic factors affecting the cost of marketing and distribution, has been published. A preliminary investigation of the sources, accuracy, and use of market reports on live stock and meats has been made. The results of this study also have been published and have been utilized in the development of plans for the organization of a demonstration market news service for live stock similar to that now conducted for perishable crops. An appropriation of \$65,000 has been made available for the purpose. Other subjects which received attention are public abattoirs, transportation of live stock, organization and methods of the wholesale meat-packing industry, and local marketing of live stock and meats.

Surveys have been made of the marketing facilities for agricultural products in nine cities and advice has been given regarding the location, establishment, and management of municipal retail and wholesale public markets. Detailed studies also have been made of local conditions in other cities. The department now is prepared to furnish a model design for a public retail market, with the cost, fully equipped, estimated on the basis of square feet. Designs of model steel sheds for use on open farmers' markets also are available.

Investigations concerning methods of handling and grading perishable products and the practicability of the standardization of the products and their containers have progressed rapidly. Tentative grades for sweet potatoes of Arkansas and Bermuda onions of Texas have been worked out and adopted by the local growers' associations. Several standardization laws, Federal and State, have been enacted during the year. The most significant Federal legislation in this field is the United States Grain Standards Act. Congress also has established the 2, 4, and 12 quart sizes, with certain dimensions, as standards for Climax baskets for grapes and other fruits and vegetables, as well as the dry-measure one-half pint, pint, quart, or multiples of the quart as standards of capacity for baskets or other containers for small fruits, berries, and vegetables.

Preliminary plans have been formulated for the investigation of foreign markets for American farm products and for assistance in the development of the export trade under normal conditions. A representative of the department recently conducted investigations in Europe along this line. The work, in so far as possible, will be

done in close cooperation with the Departments of State and Commerce.

A survey of State marketing activities has been made and the results published. Provision was made in the Appropriation Act for the fiscal year 1917 for cooperation with the several States in the employment of marketing agents. This provision should enable the department to bring about a close coordination of the marketing activities and policies of the various States with those of the department.

DEMONSTRATION MARKET NEWS SERVICE.

The value to producers of fruits and vegetables of the experimental market news service inaugurated in 1915 resulted in insistent demands for the extension of the work. During the past year telegraphic reports have been received from 33 important metropolitan markets and from officials of all railroads serving producing territory. The information thus secured has been furnished to growers, shippers, and distributors through 35 temporary offices in producing territories and 11 permanent offices in large cities. Statements from growers and shippers of tomatoes, strawberries, peaches, cantaloupes, watermelons, onions, grapes, apples, and potatoes indicate that the actual monetary saving due to a wider knowledge of market conditions has exceeded the cost of the service many fold.

The education of producers in the proper marketing of farm products, the avoidance of unnecessary losses due to diversions in transit, and the encouragement given to growers who desire to reach new consuming centers are some of the benefits resulting from this attempt to develop for the farmer a reliable business basis.

THE COTTON FUTURES ACT.

The work under the Cotton Futures Act, which was reenacted with amendments at the last session of Congress, progressed satisfactorily. In addition to the Official Cotton Standards of the United States, which were promulgated on December 15, 1914, official cotton standards for tinges and stains were promulgated on January 28, 1916. Reproductions of these standards were furnished the future exchanges and spot markets which have adopted the official standards for white cotton.

While the compulsory use of the official standards extends only to contracts on future exchanges made subject to section 5 of the act, they were accepted and used voluntarily in all the more important spot markets and form the basis of their dealings. Demonstrations of the use of the standards have been conducted among farmers in many of the cotton-producing districts of the South, and arrangements have been made to provide 125 county agents in that region with reproductions of the standards. The interest in, and approval of, the Official Cotton Standards is not confined to this country. This is shown by the fact that the Rotterdam Cotton Exchange has adopted them.

As a result of the operation of the Cotton Futures Act, quotations for spots and futures have maintained a steady relation to each other. Future quotations now are better indications to the farmer of the value of his commodity than formerly. This uniformity has demonstrated the value of the future markets for legitimate hedging purposes. It is clear, therefore, that the general purposes of the act have been, and are being, accomplished.

GRAIN STANDARDS AND WAREHOUSE ACTS.

The Office of Markets and Rural Organization, in cooperation with the Bureau of Plant Industry, has been charged with the duty of administering the United States Grain Standards Act. Plans for its enforcement have been developed as rapidly as possible.

Official standards for shelled corn, effective December 1, 1916, were issued on September 1. These standards consist of 6 grades each for white corn, yellow corn, and mixed corn, and also a sample grade, making 19 grades in all. As the inspection requirements of the act are not operative as to any grain until standards for it have been established thereunder, the supervision of inspection and grading for the present will be confined to corn. Standards for wheat and oats are in process of determination. Studies for the purpose of securing the information necessary to establish standards for other grains, including the grain sorghums, are under way.

Tentative rules and regulations for the enforcement of the act were published and distributed on October 14, 1916, and all interested parties were given an opportunity to make suggestions concerning

them. Public hearings were held in four of the large grain marketing and exporting centers and in Washington. The suggestions received by letter and at the hearings were fully considered in drafting the final form of the rules and regulations, which were promulgated on November 6, 1916, effective December 1, 1916.

Examinations have been held at various points to determine the competency of persons who have applied for licenses to inspect and grade shelled corn and to certificate the grade thereof. Licenses relating to other grains will not be issued until standards for them have been established.

In order that the work of licensed inspectors may be supervised properly, and appeals and disputes under the act dealt with promptly, it has seemed advisable for the present to divide the country into 32 districts. This number may be increased when standards for other grains have been established. The districting has been made with a view to place all sections of the country in convenient reach of a grain supervisor. In each district there will be an office of Federal grain supervision, usually in charge of a grain supervisor or a board of grain supervisors. The city in which the office is located has been designated in each case as the district headquarters. The right to appeal or to refer a dispute in all cases must be exercised by sending the question for determination to the grain supervisor in charge of the particular district under whose jurisdiction it falls.

Grain producers and all branches of the grain trade have shown a commendable desire to cooperate with the department in bringing about the most beneficial operation of the law.

The administration of the United States Warehouse Act has been intrusted to the Office of Markets and Rural Organization. The rules and regulations for its enforcement are in course of preparation. A tentative draft will be published in the near future, and all interested parties will be given an opportunity to submit suggestions.

THE FOOD SUPPLY.

Interesting questions arise as to whether the domestic food supply of the Nation is keeping pace with the growth in population and as to what are the prospects for the future. The following table in this connection is illuminating:

Food supply of the United States.

Population: June 1, 1900.....	75,994,575
June 1, 1910.....	92,174,515
June 1, 1916.....	101,882,479

Item.	Production.	
	Total.	Per capita.
Meats: Beef, veal, mutton, and pork (pounds):		
1899.....	18,865,000,000	248.2
1909.....	19,712,000,000	213.9
1915.....	22,378,000,000	219.6
Dairy products:		
Milk (gallons)—		
1899.....	7,265,804,304	95.6
1909.....	7,466,406,384	81.0
1915 (estimated ^a).....	7,696,844,000	75.5
Butter and cheese (pounds)—		
1899.....	1,790,097,244	23.6
1909.....	1,942,378,069	21.1
1915 (no data available).....		
Poultry products:		
Poultry raised (number)—		
1899.....		
1909.....	488,500,000	5.3
1915 (estimated).....	555,500,000	5.5
Eggs (dozens)—		
1899.....	1,294,000,000	17.0
1909.....	1,591,000,000	17.3
1915 (estimated ^a).....	1,811,000,000	17.8
Fish (pounds):		
1900-1904.....	989,275,000	^b 12.5
1908.....	1,046,541,000	^c 11.6
1915 (no data available).....		
Cereals: Corn, wheat, and rice (bushels):		
1899.....	3,333,868,710	43.9
1909.....	3,257,407,468	35.3
1915.....	4,094,986,999	40.2
Potatoes (bushels):		
1899.....	273,318,167	3.6
1909.....	389,194,965	4.2
1915.....	359,103,000	3.5
Sweet potatoes (bushels):		
1899.....	42,517,412	.56
1909.....	59,232,070	.64
1915.....	74,295,000	.73
Citrus fruits: Oranges, lemons, and grapefruit (boxes):		
1899.....	7,075,557	.093
1909.....	23,447,044	.254
1915 (estimated).....	24,670,282	.272
Orchard fruits: Apples, peaches, and pears (bushels):		
1899.....	197,455,620	2.6
1909.....	190,433,327	2.1
1915.....	304,686,000	3.0
Small fruits (quarts):		
1899.....	463,218,612	6.1
1909.....	426,565,863	4.6
1915 (no data available).....		
Sugar (pounds):		
1899.....	486,006,871	6.4
1909.....	1,688,390,143	18.3
1915.....	2,025,680,000	19.9

^a Based upon average annual increase, 1899 to 1909, as shown in census.

^b Based upon population, June 1, 1902, 79,230,563.

^c Based upon population, June 1, 1909, 90,556,521.

These statistics cover the past 16 years. Within this period the population of the Nation has increased, in round numbers, 26,000,000, or 33 per cent. The articles dealt with cover the more important parts of the diet of the people. Meats and dairy products constitute 37 per cent of the average diet, fish 2 per cent, cereals 31 per cent,

Irish and sweet potatoes 13 per cent, and other vegetables 8 per cent. It is notable that, notwithstanding the very rapid increase in population, the production per capita of the commodities indicated, with the exception of meats and dairy products, has remained approximately the same or has increased.

Similar statistics are not available for vegetables, other than Irish and sweet potatoes, but it is reasonable to assume that there has been at least a proportionate increase in production. The figures for Irish potatoes may be taken as a fair index of the normal increase of vegetable products. The potato acreage increased from 2,938,778 in 1899 to 3,668,855 in 1909, or 24.8 per cent, while the value of the product increased during the same period from approximately \$98,400,000 to approximately \$166,400,000, or 69.2 per cent. The value of all other vegetables increased during the 10-year period from \$120,000,000 to \$216,000,000 and the acreage by over 600,000. The statistics regarding canned vegetables are significant. In 1899, 19,300,000 cases of canned vegetables, valued at approximately \$28,700,000, were packed in the United States. In 1909, 32,800,000 cases, having a value of approximately \$51,600,000, were packed.

The area from which vegetables are drawn constantly is increasing, and improved canning, marketing, and transportation facilities have made it possible to supply our large markets with vegetables in greater variety throughout the year. It is a well-known fact that the consumption of fruits and vegetables has increased considerably in recent years and that they constitute a larger and more important part of the permanent diet of the people.

With all the agencies now available for improving agriculture there is ground for optimism as to the ability of the Nation not only to supply itself with food, but increasingly to meet the needs of the world.

INCREASING THE MEAT OUTPUT.

To increase the meat production of the United States has been one of the principal aims of the department in recent years. This can not be accomplished in a day, but requires steady constructive effort over a period of years. Whatever may have been the influence of the department's work, it is gratifying to note that the decline in beef production reached its lowest point in 1913, and that since that date there has been a material increase, while there has been a marked advance

in the number of swine since the census year 1899. The number of sheep has continued to decline, but only to a slight extent. The number of animals slaughtered and the quantity of meat products prepared under Government inspection during the past fiscal year are the largest in the history of the service; yet this heavier slaughtering has been accompanied by an increase in the remaining stock of animals.

In December, 1913, a committee of experts was appointed to make a thorough survey of the meat situation. As a result of this study, the department recently issued a series of illuminating reports. They furnish information of value not only to the public but also to the department and suggest more definitely the lines of attack which the department should follow in its efforts to increase the meat supply.

The activities of the department have taken two principal directions—(1) checking and eliminating diseases and parasites and (2) increasing and improving stock raising by extending the industry where conditions are favorable and by pointing the way to better breeding and feeding.

COMBATING STOCK DISEASES.

The eradication of the southern cattle tick is proceeding more rapidly than ever before and is opening up for beef and dairy production a large territory. During the past fiscal year 31,358 square miles were released from quarantine and, in addition, 9,493 square miles were released on September 15, 1916. Within the past three years the quarantine has been removed from 106,810 square miles, making a total of 294,014 since the work was begun in 1906. This represents a territory greater than the combined areas of South Carolina, Georgia, Florida, Tennessee, Alabama, and Mississippi. More than 40 per cent of the original tick-infested territory has been cleared, and therefore the direct losses, originally estimated at \$40,000,000 annually, are being greatly reduced.

The diseases known as sheep scabies and cattle scabies likewise are being eliminated rapidly from the Western States. During the fiscal year 1916, 43,243 square miles were released from quarantine for sheep scabies and 12,691 for cattle scabies. At present only 286,398 square miles remain under quarantine for sheep scabies and 3,817 for cattle scabies.

Hog cholera.—Hog cholera, always the cause of heavy losses throughout the country, is less prevalent this year than for many years. This is due, in marked degree, to the wise application of the protective serum devised by the department and to the demonstration work in certain selected counties. The beneficial results of the field demonstrations are shown by a comparison of statistics for the 14 experimental counties before the work was undertaken and after it had been in progress for a time. There was an increase in the number of hogs raised in these counties from 859,910 in 1912 to 1,334,644 in 1915, while during the same period there was a decrease in the number that died from 152,296 to 30,668. This is an increase of 474,734 in the number raised and a decrease of 121,628 in the number lost, or a total gain of 596,362 hogs. This demonstration shows what can be accomplished by the use of serum with sanitary measures, and undoubtedly has led to the extended use of such methods by farmers. The experimental plan would be impracticable and too expensive for the department to operate on a large scale, but the work will be continued in a modified form.

Contagious abortion.—Contagious abortion in recent years has reached such proportions as seriously to threaten the cattle-raising industry. It strikes at the source by curtailing the production of calves. It has been studied by the department, and vigorous efforts are being made to advise stock breeders as to its nature and means of prevention and eradication. The last Congress, upon the recommendation of the department, made a special appropriation of \$50,000 for attacking the problem.

Foot-and-mouth disease.—I am glad to be able to report the complete suppression of foot-and-mouth disease during the year. The disease appeared near Niles, Mich., late in the summer of 1914 and reached 22 States and the District of Columbia. It extended entirely across the country, from Massachusetts on the east to Washington on the west, the region of greatest prevalence being from New York to Illinois.

After July 1, 1915, the disease occurred only in Illinois, Massachusetts, New York, Indiana, and Minnesota. Before the end of August it had been eradicated from the last three mentioned States. It recurred in Massachusetts in October, 1915, and was promptly suppressed. In Illinois the last herd of cattle affected by the natural

spread of the disease was disposed of in February, 1916. The infection reappeared, however, early in May among some test animals on a previously infected farm. These animals had been placed there to determine, before the owner was allowed to restock his farm, whether the disinfection was effective. As the cleaning and disinfection of these premises had been done under very unfavorable weather conditions, the outbreak was not entirely unexpected. The diseased animals were slaughtered promptly and the premises again disinfected. There has been no recurrence of the disease anywhere in the United States. The last quarantine restrictions were removed June 5, 1916. Supervision by veterinary inspectors has been continued in the lately infected areas after removal of quarantine, as a precaution against any infection that may have remained.

This outbreak was the most serious invasion of this disease that has ever menaced the live-stock industry of the country. It was overcome only after a hard struggle in which the authorities of the various States affected cooperated cordially with the Federal Government. We are fortunate to have escaped with no greater losses. Other countries have been unable to eradicate the disease after it has gained a foothold and have to endure constant heavy losses. As a protection against future outbreaks of this or other diseases of a character to threaten seriously the live-stock industry, Congress has made a special appropriation of \$1,250,000. It also has provided, upon the recommendation of the department, that breeding value, as well as meat or dairy value, may be taken into account in compensating owners for animals destroyed hereafter in the eradication work.

TUBERCULOSIS OF FARM ANIMALS.

Tuberculosis probably is the most common, destructive, and widely disseminated of the infectious diseases of domestic animals, especially of cattle and swine. Its seriousness is emphasized by the fact that it is transmitted to human beings. This may be prevented in reasonable measure by the pasteurization of milk and the inspection of meat. There remains, however, the problem of eliminating the disease from farm animals in order to prevent losses estimated at \$25,000,000 a year in the United States. This is the greatest problem confronting the live-stock industry of the country. Its

very magnitude discourages the undertaking of any general plan of eradication.

Despite all that has been done in the past 10 or 15 years, there is no indication that tuberculosis of cattle and hogs is on the decline in the United States. It has been reduced or partially checked here and there, and even eradicated from some herds; but generally it is as prevalent as ever. The disease can be prevented and some definite system of eradication should be inaugurated. Three undertakings seem practicable at this time.

Eradication from pure-bred herds.—The first is the eradication from pure-bred herds of cattle. It is not necessary to resort to compulsion. The department should be placed in position more fully to assist individuals who wish to undertake the complete eradication of the disease from their herds. It could apply the tuberculin test and, in case infected animals are discovered, advise and supervise their proper disposal or management. The ruthless slaughter of all tuberculin reactors is not necessary. Many of them may be safely retained under proper quarantine conditions and their offspring raised free from tuberculosis. This plan has the approval of the breed-record associations in general and of many individual breeders. Numbers of breeders have requested that their herds be tested. Compliance with these requests to the extent of the limited funds available has yielded very satisfactory results.

Eradication from hogs.—The second undertaking is the eradication of tuberculosis from hogs. The experts of the Bureau of Animal Industry believe that this would be relatively easy of accomplishment. Hogs do not convey the disease to one another to any appreciable extent. They contract it from cattle, chiefly in two ways—by being fed on nonpasteurized products from creameries and by following cattle of somewhat mature age in the feed lot and feeding upon the undigested grain. An educational campaign should be effective in removing these two sources of infection. It also may be desirable to have State laws requiring the pasteurization of skimmed milk and other products before they leave the creameries.

Eradication from restricted areas.—The third undertaking is complete eradication in restricted areas. The plan would be to select certain communities in which, after a thorough educational campaign had been made, the stock owners are willing to cooperate in

eradicating the disease entirely from that territory. This would require the slaughter of infected animals and would necessitate reasonable indemnity for the animals slaughtered. The latter feature undoubtedly would require large expenditures.

The results accomplished in the District of Columbia afford an example of what can be done where systematic local eradication is undertaken. By means of repeated tuberculin testing, accompanied by the slaughter of the reacting animals, tuberculosis among cattle in the District has been reduced in a few years from nearly 19 per cent to slightly over 1 per cent. The joining of areas freed of tuberculosis in the manner proposed gradually should result in the elimination of the disease from groups of counties and from entire States.

Such an undertaking would be very similar to the plan of exterminating cattle ticks in the South. This work was begun systematically in 1906 in certain restricted areas on the border of the infested region. At first the opposition of the local people was almost unanimous. Even the fact that the tick is the carrier of splenic fever was quite generally disbelieved. Persistent work in these few regions, however, eventually produced good results. Gradually the people were convinced that the tick is an evil; that its eradication would be advantageous; and that the cost would be small in comparison with the benefits. The tick-eradication movement is now going forward very rapidly. Furthermore, this activity was begun almost exclusively at department expense. Last year the department spent approximately \$400,000 in tick eradication, while local agencies, including State and county governments, expended double that amount, or \$800,000. This indicates what can be done when the people concerned appreciate the real significance and value of an undertaking.

Such a plan should succeed against tuberculosis. It is a large task. Its feasibility will have to be thoroughly established first, as was the case with tick eradication. In the beginning the methods for tick eradication were crude and cumbersome. Improvements were made, however, until the present efficient system was developed. These suggestions, if carried into effect, should assist in developing a comprehensive plan for dealing with the tuberculosis situation which will meet with approval and lead to ultimate success. The department has recommended in the estimates for the next fiscal year that an appropriation of \$75,000 be made for the inauguration of the work.

DEVELOPMENT OF STOCK RAISING.

Experiments by the department, in cooperation with the State experiment stations, have shown conclusively that the South is well adapted to economical beef and pork production. It is beginning to take its place with other sections as a stock-raising territory. Numerous breeding herds are being established. The leading beef-cattle breeders' associations are featuring the southern trade, and two of them are holding sales in cooperation with the department. Cattle from southern herds have won the highest honors in northern show rings, and steers from southern feed lots, after being properly fattened, now command good prices in northern markets. This work is not for the benefit of one section alone; the entire country will profit from the extension of meat production into new territory.

A study of growing beef animals in the corn belt also was made, and records were obtained of the cost of raising calves from nearly 15,000 cows. The results show that calves, as a rule, can be raised at a profit, although the cost of production is higher than is usually thought.

The boys' and girls' pig and poultry clubs are valuable agencies for enlarging the meat output, as well as for training and developing the coming generation of farmers. The membership of both classes of clubs more than doubled during the year. The pig clubs now have more than 21,000 members and the poultry clubs 8,500.

National Forest ranges.—The investigations conducted at the instance of the committee appointed to study the meat situation indicate that there has been an increase of from 15 to 30 per cent in the carrying capacity of the National Forest ranges. This has been brought about by systematic regulation, better methods of handling stock, improving and increasing the number of watering places, opening up unused or inaccessible ranges, the building of drift fences, and the lessening of losses from poisonous plants. These ranges now are supporting over 1,750,000 cattle and 7,850,000 sheep, exclusive of calves and lambs. It is estimated that within the next 10 years their carrying capacity will be increased by an additional 15 per cent and that they will be capable of supporting fully 2,000,000 cattle and 9,000,000 sheep.

As previously pointed out, regulated grazing on the public lands outside the National Forests would permit a considerable addition

to the country's meat supply. At present these lands, which include an area of over 250,000,000 acres, are not supporting the number of animals that formerly grazed upon them. By the application of a system of control and development similar to that used on the National Forests, it would be possible greatly to increase the number of meat-producing animals upon the public ranges.

Destruction of forage by rodents.—The grazing value of the western stock ranges is much reduced by the depredations of prairie dogs and ground squirrels. More than 22,000,000 acres in 12 States are infested with prairie dogs. These rodents often completely destroy the forage plants over considerable areas and cause enormous damage to grain and other crops. Ground squirrels occur in large numbers in 18 States. While they are less destructive to forage plants than prairie dogs, they consume large quantities of forage and grain. In North Dakota alone the annual loss to farmers from the destruction of grain by ground squirrels is estimated at over \$3,000,000. The Bureau of Biological Survey has developed new methods of poisoning these pests at a cost of approximately 5 cents per acre. This is less than the grazing value of the land for a single year. The bureau practically has eradicated prairie dogs from more than 2,000,000 acres of public lands and ground squirrels from 500,000 acres. The complete elimination of them should enable the ranges and farms of the West to carry a million cattle and a million sheep more than at present.

Predatory animals.—The annual losses of live stock in the United States, mainly upon the public domain, from the depredations of such animals as wolves, coyotes, mountain lions, and bears exceeds \$12,000,000. Wolves and coyotes are subject to epidemics of rabies and, therefore, are peculiarly a menace to domestic animals and human beings. There was a serious outbreak of this disease among coyotes during the past year. It was prevalent in several States in the Northwest and was especially disturbing in Nevada.

Congress appropriated \$200,000 for the destruction of predatory wild animals during the past year. The sum of \$250,000 is available for this purpose during the fiscal year 1917. A force of hunters and trappers has been organized in the infested States, and 543 wolves, 19,170 coyotes, and many other predatory animals have been destroyed. As a single wolf has been known to kill more than \$3,000

worth of stock in one year, the effect on the stock-raising industry of the elimination of this number of destroyers is apparent. A continuance of the campaign should eliminate a large part of the losses from this source and also should check the spread of rabies among wild animals.

THE SHEEP INDUSTRY.

Normally the United States imports from about two-fifths to more than one-half of the wool required for domestic consumption. During the past three years importations have ranged from nearly 250 million to more than 500 million pounds each year, the average being over 300 million pounds. The total consumption of lamb and mutton during the past 10 years has increased appreciably. In the fiscal year 1907 more than $9\frac{1}{2}$ million sheep and lambs were slaughtered at plants subject to Federal inspection. The number now averages about 13 million per annum.

In some sections of the United States there has been a steady decline in sheep production since the earliest statistical reports. This has been true also in every other settled country except Great Britain. The explanation undoubtedly is an economic one. In general, the primary purpose of sheep growers has been to produce wool. This can not be attained profitably on high-priced land. Naturally, therefore, with the increase in land values there is a rapid decline in the number of sheep. In Great Britain meat has been the principal product and wool the by-product, and the sheep industry has flourished.

Waste land made productive.—If American farmers will follow the British custom the industry can be put on a profitable and permanent basis. The greater number of sheep in Great Britain are raised in the hills and on land comparable to much of the "waste land" of American farms. The areas in this country, especially in the East and in parts of the South, now relatively little used, can profitably be devoted to sheep production if the farmers will secure the proper breed of sheep.

Sheep also can be made profitable on higher-priced land, as British experience shows. They compare favorably with other animals in economy of production. They require a minimum of expensive concentrated feeds. They exceed the other larger animals in the rate of maturity; lambs can be made ready for market at from four to

six months. They make possible the economical and fuller use of labor. They are of assistance in keeping the farm free from weeds. The sheep farm is usually a weedless farm.

Extension of industry.—In the United States only one in seven farms of over 20 acres now supports sheep, with an average of one sheep of shearing age to 3 acres of land. The 300 million pounds of wool now imported annually could be secured from 50 million sheep, and this number could be added to our stock if a fourth of the remaining farms sustained one sheep for each 3 acres.

In 1914 the Animal Husbandry Division of the Bureau of Animal Industry and the Bureau of Crop Estimates canvassed crop reporters in 36 States in reference to sheep on farms. The replies indicated that the number could be increased 150 per cent without displacing other animals. It is to our settled areas, particularly in the Central, Southern, and Eastern States, that we must look for an increase in the number of sheep.

THE DAIRY INDUSTRY.

The profits of agriculture ultimately depend on the intelligent cultivation of the soil and the preservation of its fertility. Dairy farming is increasing in almost every section of the country, largely because it is the most economical form of agriculture so far as soil fertility is concerned. A ton of butter removes from the soil less than a dollar's worth of fertilizing elements. Dairying also is growing because dairy products are an important part of our food supply. Opportunities for dairying are found in every agricultural district. The different sections of the country have characteristic peculiarities, but all need milk and its products.

Cheese production.—In 1909 this country produced 1,622 million pounds of butter and 321 million pounds of cheese. In 1870 our cheese exports amounted to 57 million pounds. They steadily increased until 1881, when the total was 148 million pounds. After that date they decreased rapidly until in 1914 they had dropped to less than $2\frac{1}{2}$ million pounds. On the other hand, our imports of cheese amounted to $2\frac{1}{3}$ million pounds in 1870 and advanced slowly until 1900, when $13\frac{1}{2}$ million pounds were imported. From 1900 to 1914 the imports increased to 64 million pounds. Much of this cheese could and should be produced in the United States.

Most of the cheese in this country has been made in the territory around the Great Lakes, where climatic conditions are favorable to the handling of whole milk. All the valleys in the Rocky Mountain section and a large area on the Pacific coast offer splendid conditions for cheese production. So, also, does the mountain section of the South, including parts of West Virginia, Virginia, Tennessee, North Carolina, South Carolina, and Georgia. Three factories have been established in one of these States and have been very successful.

Cooperative associations.—Rigid selection, intelligent breeding, and skillful feeding are important factors in economical production. Cow-testing associations teach rigid selection and skillful feeding. Cooperative bull associations promote intelligent breeding. In cooperation with the various State agricultural colleges the department has greatly extended the work of these associations. For several years cooperative bull associations have been common in some parts of Europe. The first association of the kind in the United States was organized in Michigan in 1908. In this country their growth has not been rapid, but as a rule they have been successful. They provide for the joint ownership, use, and exchange of high-class, pure-bred bulls. If skillfully managed, these associations should become potent factors in the upbuilding of a more profitable dairy industry.

A large part of the work of the cow-testing associations and cooperative bull associations has been done in the North and West. In Wisconsin alone there are more than 50 cow-testing associations, while the cooperative bull associations have been especially successful in Massachusetts, northern Michigan, and North Dakota. The dairy industry in the Rocky Mountain and Pacific Coast States recently has made great progress, owing in part to the importation of carefully selected dairy cows and registered bulls from the East and Middle West. Its development in the South has been very marked during the past year. A beginning was made in the work of cow-testing associations and cooperative bull associations. Five of the agricultural colleges have organized creameries to encourage dairying and to provide a market for the increased production of milk and cream. These creameries furnish excellent facilities for teaching students improved methods of manufacturing and handling dairy products.

Community development in dairying.—Community development in dairying was undertaken by the department in a typical small creamery community in northern Iowa in 1910. The object of the experiment was to determine the practicability of employing skilled instructors to assist such communities in bringing the dairy business to a higher level. The work, which proved to be financially successful, was continued for five years, and similar work now is being carried on, with even greater success, in the vicinity of Grove City, Pa. If the 5,000 creameries in this country should adopt the community-development plan, it doubtless would result in greatly enlarged profits for the patrons.

The creamery extension work has increased the efficiency of a large number of creameries. The department also has given assistance in building and equipping creameries, rearranging the machinery, systematizing the methods of operation, eliminating losses, and improving the quality of the products.

Research work.—The activities indicated are almost entirely of an educational nature. The department also is conducting investigations relating to dairy problems on a scale which is unequalled anywhere else in the world. Much of this work, in its beginning, is of a highly technical nature, but results are being accumulated which are of great practical value in the field demonstration work. Extensive study of the types of bacteria in milk, their origin, and the channels through which they contaminate milk, has established a reasonable basis for dairy sanitation. Perhaps the most striking example of the application of the results of laboratory research to practice is the development of methods of manufacture of some of the foreign cheeses which make up the bulk of our cheese imports.

PRODUCTION OF FOOD CROPS.

The production of food crops adequate to meet the consuming needs of the country and the export demand is a matter of large importance to the American people. Our potential agricultural resources in this respect are so varied and ample that there can be no doubt of our ability abundantly to supply our domestic wants, when climatic conditions are normal and the foreign demand is not excessive. One of the greatest agricultural needs, therefore, is the stabilizing of production.

Sharp fluctuation of yield and price from season to season tends to stimulate speculative and superficial farming and to discourage the systematic crop rotation and thorough cultural practice which are essential to an enduring and economically sound agriculture. It is obvious that, in large measure, stabilization of production must be brought about through the use of better adapted or improved crop varieties, more systematic and rational crop rotations, and improved agricultural practice generally, including, in many sections, larger attention to live-stock production.

The extent to which the productiveness of such a crop as corn can be improved through continued selection is illustrated strikingly by the results of work done by department specialists. For 14 seasons the yields of 10-acre fields of corn, planted on a 3,000-acre farm in Ohio with seed selected from the department cooperative improvement plots on the farm, have been contrasted with the farm yields of the same variety of corn less rigidly selected and grown under identical cultural conditions. During the first seven-year period the fields planted with department seed yielded 13.3 bushels per acre more than the farm fields, while for the second seven years the increase averaged 21.8 bushels per acre.

It should not be inferred that such increases in yield can be secured except through very efficient crop-improvement work; yet it is obvious that, as the principles of crop improvement are better understood and more generally applied, larger yields per acre should result. In addition, a great deal can be accomplished through increase of soil fertility and better cultural methods. Enough has been done in this direction by the State experiment stations and the department, and also by good farmers, to justify the expectation that considerably increased acre yields gradually will be brought about in a large part of the area adapted to the staple food crops.

EXTENSION OF AREAS OF PRODUCTION.

Very destructive climatic conditions never occur in this country with equal severity throughout all the staple-crop regions. It is highly desirable, therefore, further to broaden the areas for these staples as far as experience and sound economics may warrant. While progress in this direction necessarily is slow, it is gratifying to note that in recent years the production of corn in the Southern

States has increased greatly. At the same time the frontier of commercial corn production has advanced steadily northward in the upper Mississippi Valley and Plains States.

Farther south and west, especially in western Kansas, Oklahoma, and the Panhandle of Texas, corn is being displaced to a considerable extent by the grain sorghums because they more regularly produce profitable crops. Approximately 4 million acres now are devoted to these crops. One of these sorghums has been changed by systematic breeding into a standard variety which produces a much larger yield of grain. Dwarf milo, a recent result of systematic breeding for low stature, has a higher grain-yielding power under adverse conditions than the tall variety. During the past four years it has become the leading variety grown in Oklahoma, Texas, and New Mexico. As the sorghum grains in large measure serve the same purposes as corn, the economic soundness to the Nation of their enlarged production is apparent.

In the Sacramento Valley of California, where this department has been investigating the possibility of rice culture, the acreage devoted to that crop has increased during the past five years from 1,400 to 67,000. The farm value of the current crop approximates \$5,500,000. The increased production of wheat, oats, and other small grains in the Southeastern and South Central States, which was specially stimulated by the cotton-market crisis of 1914, tends to stabilize the food supply. In several States the acreage planted to these grains was enlarged by from 50 to 100 per cent.

Adaptation studies of the hard red winter wheats, which formerly were restricted to a limited part of the Central Plains region, have shown that they can be grown throughout a much larger area. During the past four years they have become established extensively in Montana and in the States of the Great Basin and the Pacific Northwest. In the States west of the Rocky Mountains they have largely replaced the soft wheats.

The area devoted to durum wheat has strikingly increased. This crop now is well established in western North Dakota, South Dakota, eastern Montana and Wyoming, and northeastern Colorado. As the durum varieties are more resistant to rust than other types and require less rainfall, their introduction by the department has proved to be of very great importance to the country. The durum produc-

tion already has attained a magnitude of 40 million bushels in a single year.

Two new pure lines of Kherson oats have been developed in cooperation with the Iowa Agricultural Experiment Station and have been widely distributed in Iowa and adjoining corn-belt States. A large number of tests by farmers have shown a 10 per cent increase in yield over the varieties previously grown. Their adoption for the entire oat acreage of Iowa probably would result in an increase in production in that State alone of from 12 to 15 million bushels.

A systematic study of the soy bean, with a view to determine the relative adaptability of varieties to regions, the best methods of culture, harvesting, and threshing, and the uses to which it can be put, has been under way for several years. This study has thrown much light on its economic possibilities. It not only produces forage for live stock, but oil for various uses can be obtained from the seed, and meal, flour, and other food products can be made from the resulting cake. Through the efforts of the department, cotton-oil mills crushed during the past season over 100,000 bushels of southern-grown soy beans with satisfactory results from the oil standpoint, while soy-bean flour, or meal, and other food products made from the resulting cake, are being marketed by several manufacturers.

As the soy bean can be produced under widely varying climatic and soil conditions, it seems certain in the future to occupy a larger and more important place in our agriculture and in our food supply.

CALIFORNIA CITRUS INDUSTRY.

The citrus industry of California, although tracing its beginnings back to individual plantings by early settlers, owes its present magnitude and commercial importance in large measure to the introduction by this department many years ago of the Washington navel orange from Brazil. The present production of this variety in that State is estimated at approximately 27,000 carloads in a normal year, or about two-thirds of the total orange shipments of the State. It has, in fact, become the most important citrus-fruit variety in the world.

The results of several years of systematic study of citrus fruits in California show that important bud variations exist, even in standard varieties. This factor must be taken into account in their propagation in order to secure maximum productiveness and quality. In

many of the best groves at least 10 per cent of the trees of the standard varieties are of inferior strains, which should be eliminated by top-working. The growers who have observed the experimental plots realize the importance of this work and already have undertaken the conversion of the undesirable trees by top-working on a rather large scale. This study will be extended to some of the deciduous-tree fruits.

As the economic soundness of commercial fruit orcharding to a considerable extent rests upon the maintenance of high average annual production, it is obvious that the results of this investigation are of fundamental importance to the fruit industry.

SUGAR-BEET INDUSTRY.

The production of beet sugar in the United States has increased during the past four years from less than 700,000 tons to approximately 900,000 tons. During the past year seven new localities for sugar-beet production have been developed. But for the existing shortage of sugar-beet seed a considerably larger increase of production would have been secured.

Stimulated by the inadequate supply of seed from European countries American growers now are undertaking seriously the production of seed. Approximately 4,000 acres, which should produce about one-fourth of the present requirements, have been devoted to this purpose during the current year. A special appropriation made at the last session of Congress will enable the department to cooperate with the industry in solving some of the more technical problems involved. It is hoped that, as a result of this work, the industry may be freed from the menace of seed shortage which during the past two years seriously threatened its existence.

CONTROL OF PLANT DISEASES.

It is very clear that fuller knowledge of the distribution and the nature and methods of control of crop diseases is essential. In some seasons, when unusual climatic conditions prevail at critical periods, diseases greatly lessen or practically destroy particular crops throughout important producing districts. Progress has been made in determining their exact character and in developing methods of control, but the destructiveness of certain diseases under climatic conditions favorable to their spread necessitates

still more energetic inquiry. It has been estimated that in years when cereal rusts are epidemic the losses from them alone amount at least to \$180,000,000. No effective remedies have yet been found for these diseases. It seems probable, however, that through the development of suitable resistant varieties their eventual control in large part can be effected.

Distinct headway has been made in the study of diseases of fruits and vegetables. Many of them have proved amenable to spray control, especially when combined with rational field practice to prevent infection.

CITRUS CANCKER.

Cooperative arrangements have been made with State officials of Florida, Texas, Louisiana, Mississippi, Alabama, Georgia, and South Carolina to insure the thorough inspection of nurseries and citrus groves for the purpose of promptly and completely eradicating citrus canker. This is an undertaking of great magnitude because of the extreme infectiousness of the disease and the wide area throughout which it has been disseminated. No final statement as to the outcome can be expected within a period of at least two years. The campaign, however, is progressing very satisfactorily in the commercially important orange and grapefruit regions of Florida. Supplemental protective measures, such as formalin treatments of infected soil and protective spraying of groves exposed to infection, are hastening the work of eradication materially. Even in the few places where citrus-canker outbreaks have occurred in commercial districts and in old trees, the disease can be eradicated promptly and effectively. Although thorough inspection of citrus plantings will be necessary, at least throughout the coming fiscal year, it is believed that Florida now is so nearly free of the disease as to render its eradication from that State practically certain. In Texas, Louisiana, Alabama, and Mississippi the work has been more difficult from the beginning because of the more scattered plantings and the relatively smaller interests involved. Furthermore, in all these States the unusually severe tropical storms of the present year have caused unexpectedly wide distribution of the disease in some areas. Even in these States, however, the progress of the work is encouraging, and if no further unusual drawbacks are encountered the disease will be effectively checked.

CONTROL OF INSECTS.

While all the State Experiment Stations support work in economic entomology, and while many other countries are developing services in this direction, the Department of Agriculture has by far the largest organization for the purpose of research on insect pests. It is virtually the leader of the world in the warfare against injurious insects. It has in its files biological notes on thousands of species and is studying them from all points of view in its field laboratories. No less than 143 distinct projects are being investigated at the present time, involving possibly 500 of the species of insects most injurious to crops, domestic animals, stored foods, forest products, shade trees, and ornamental plants. It is safe to say that some form of remedial treatment has been found for every markedly injurious insect in the United States, but continued efforts are being made to find something more effective or cheaper or simpler.

Many striking things have been accomplished. The pear thrips, which at one time threatened the extinction of the Pacific coast deciduous-fruit industry, is no longer feared. Two serious pests of the clover-seed crop now can be handled by slight variation of cropping methods. The bark-beetles of our coniferous forests, which have imposed a loss comparable to that resulting from forest fires, can be controlled at very little expense. Sprays and spraying machinery have been developed which can be used successfully against practically all leaf-feeding species. The fumigation of nursery stock and of warehouses has been perfected. Such injurious species as the onion thrips, the grape-berry moth, the alfalfa weevil, the tobacco hornworm, and many others of recent prominence, can be controlled. The spread of the gipsy and brown-tail moths through our northern forests and orchards has been prevented. These injurious insects not only have been kept in a comparatively small territory, but are being reduced in number year after year by active scouting, spraying, banding, and egg destruction, and through the aid of parasites brought from Europe and Japan. Although the spread of the cotton boll weevil—which represents probably the most difficult problem in insect control—has not been stopped, the investigations of the department's entomologists have shown the southern planter how to reduce greatly the potential damage and how to grow cotton in spite of the weevil.

An important development in this practical entomological work of recent years has been the establishment of a number of more or less temporary field laboratories, scattered over the country. Thus the expert workers are taken into the centers of activity of the injurious species. Great stress is being laid on what may be termed the cultural method of insect control. The intimate life round of the insect pest is studied in close connection with farming methods in order to ascertain whether by variation of cultural practice the insect damage can not be considerably reduced. Remedial work of this sort is extremely practical. Investigations have shown that in many instances partial or nearly complete control can be gained by some change in farm management. This naturally is the best remedy, except possibly in the case of introduced pests, where control can be secured by the employment of parasites or other natural enemies.

Technical methods of control, mechanical and chemical, including sprays and spraying machinery, fumigation for citrus orchards, nursery stock, mills and warehouses, or trapping methods and other means of mechanical destruction also have been studied and developed. In the large problems it frequently has happened that cultural, biological, and technical measures are used at the same time.

When the enormous annual losses from injurious insects are considered it is clear that the value of the department's work in applied entomology is very great.

PLANT QUARANTINES.

Important service is rendered to the farm and fruit interests of the country, under the Plant Quarantine Act, by preventing the introduction of new and dangerous insect pests and plant diseases. There are now in force nine foreign quarantines forbidding the entry, or permitting the entry only under restrictions, of various farm, orchard, and forest products which may harbor injurious insects or diseases. The more important quarantines relate to the Mediterranean fruit fly, perhaps the worst fruit pest of the tropical and subtropical countries; the pink boll worm, an insect which threatens to become the most serious enemy known to cotton; the potato wart, a disease which not only destroys the tuber but infects the soil; and the white-pine blister rust and the citrus canker, two diseases which became established in the United States prior to the passage of the act.

A number of domestic quarantines also have been promulgated. Under these quarantines many locally established plant diseases and insect pests, most of them of recent origin, are being so controlled, in cooperation with the States concerned, that their extermination ultimately can be effected or, at least, their spread can be checked. These quarantines relate principally to the gipsy and brown-tail moths in New England; the Mediterranean fruit fly and the pink bollworm in Hawaii; and diseases of sugar cane in Hawaii and Porto Rico.

In some instances plants and plant products are admitted only after certification by the proper official in the originating country and the issuance of permits by the department. They also are inspected by State or Federal experts before being released in this country. Such restrictions now apply to nursery stock of all kinds, fruits, certain plant seeds, and potatoes, and foreign lint cotton. The restrictions on cotton are designed to prevent the entry of the pink bollworm through cotton seeds which are found in all imported cotton. The cotton is subjected to fumigation in a vacuum, under supervision, by a new process devised by experts of the department.

The value of this service to the Nation is apparent. Undoubtedly many, if not all, of the plant diseases and pests mentioned now would have full lodgment or wider distribution in this country if the necessary action under the Plant Quarantine Act had not been taken to prevent their entry or to check their spread. It would be difficult to compute the resulting loss.

COOPERATIVE AGRICULTURAL EXTENSION WORK.

The second year's operation of the cooperative Agricultural Extension Act of May 8, 1914, has been attended with a steady development of the nation-wide system of practical instruction in agriculture and home economics discussed in my last two reports. There has been a fuller coordination of the activities of the department with those of the agricultural colleges and more complete development of the relations between the extension forces in the States Relations Service and the scientific staffs in the various bureaus of the department, resulting in the better dissemination of approved scientific information.

POTASH FROM KELP.

In 1911 the Bureau of Soils was authorized by the Congress to make a survey of the Nation's resources in fertilizer materials, par-

ticularly in potash, for which this country was entirely dependent upon the German mines. As a result of this reconnoissance, it became evident that the largest and most immediately available source of potash in this country was the giant kelps of the Pacific coast. This conclusion was reached after detailed surveys had been made of the kelp groves of southern California, the Puget Sound region, and Alaska. The attention of the public was called to this source in the hope that private capital would undertake its development.

Germany in 1915 prohibited the exportation of all potash salts. This action greatly stimulated the attempts of American manufacturers to produce potash and resulted in the erection of eight large plants in southern California for the extraction of this material from kelp. These establishments were constructed at a cost ranging from \$50,000 to \$2,000,000 and are centered around two cities, Long Beach and San Diego, five at the former and three at the latter place. They are operating harvesting equipment having an aggregate daily capacity of 2,500 tons of raw kelp. On September 1, 1916, about 125,000 tons of raw kelp had been harvested and treated, yielding approximately 10 per cent of dry kelp.

Notwithstanding this comparatively rapid development in the kelp industry, the problem of extracting potash from kelp commercially has not been completely solved. It is essential that methods be devised for producing the numerous by-products which can be obtained from kelp. The plants now in operation, for the most part, are engaged only in the extraction of potash. Owing to the present abnormal prices for this material, they are devoting relatively little attention to the elaboration of processes for the recovery of by-products. If this situation continues, they probably will not be able to produce potash at a profit when conditions become normal. In the circumstances, it seems desirable for the department to demonstrate the commercial feasibility of producing potash and by-products from kelp with a view to put the industry on a sound economic basis. The Congress, upon the recommendation of the department, has made available \$175,000 for the purpose. Plans have been formulated for erecting and operating, at some advantageous point on the coast of southern California, a plant with a daily capacity of not less than 200 tons of raw kelp, in order that the necessary experiments may be conducted.

It is hoped that these experiments will result in the establishment of a potash industry which will prove profitable and permanent and

render this country independent of foreign sources in normal times. In any event, information will be obtained which should be very valuable if the present abnormal conditions persist or recur.

THE FOOD AND DRUGS ACT.

Early in 1913 it became apparent that the efficiency of the Bureau of Chemistry in administering the Food and Drugs Act was impaired seriously by lack of system. The laboratories, both in and out of Washington, were congested with samples collected by inspectors. The inspectors, who were responsible only to the chief inspector in Washington, worked independently of the chemists in the branch laboratories, with resulting loss of efficiency. There was great delay in analyzing samples and in detecting adulterations. It was apparent that the work of the inspectors and of the chemists should be coordinated and more closely supervised. To make the bureau an effective agency in preventing the shipment of adulterated and misbranded foods and drugs, complete reorganization was necessary.

ESTABLISHMENT OF DISTRICTS.

Accordingly, the field service of the bureau was set off from the central organization and divided into three districts, with headquarters at Washington, Chicago, and San Francisco. A single official, whose duty it is to coordinate the work of the inspectors and the laboratories, was placed in charge of each district. Several small branch laboratories were closed and the research work was concentrated in Washington. The reorganization has effected a material reduction in the cost of operation and has made possible the accomplishment of substantial results. It has enabled the bureau to concentrate the activities of its 46 inspectors against definite lines of food and drug products. The establishment of inspection districts, together with the creation in Washington of the Office of State Cooperative Food and Drug Control, has secured the active cooperation of State food and drug officials. This cooperation has been an important factor.

Instead of attempting to deal with food products indiscriminately, the Bureau of Chemistry during the past three years has given special attention to articles in common use, such as eggs, milk, beans, shellfish, citrus fruits, tomato products, canned foods, and cottonseed meal and other feed for animals. As a result of

the activities of the bureau there has been a marked improvement in the quality of these products entering interstate commerce.

Concerted efforts of the inspectors have put an end to most of the interstate traffic in decomposed eggs. Campaigns have been conducted, in cooperation with the local authorities, to improve the milk supply of several localities. Efforts have been made to induce farmers to produce better milk and prosecutions have been instituted in many instances. As a result the milk supply of many cities and towns has been improved. Seizure proceedings have been instituted against a large number of shipments of canned beans containing substantial proportions of decomposed beans. With the assistance of the Public Health Service and the Bureau of Fisheries, sanitary surveys have been made of the oyster beds on the Atlantic coast. Sources of pollution and polluted areas were located and the information conveyed to oystermen. Seizures of shipments of polluted oysters were effected and a marked improvement in the oyster supply, from the standpoint of wholesomeness, has been noted.

Formerly it was the custom of many orange and grapefruit growers at times to pick the fruit from the trees while green or partly green in color and still unripe, and subject it to a sweating process so as to give it the characteristic yellow color of ripe fruit. The incentive to the grower was the higher price afforded by an early market. Green citrus fruit which has been colored so as to give it the appearance of ripe fruit is adulterated under the law. Several seizures have been made and the efforts of the department have resulted in a material decrease in the quantity of sweated immature fruit sent to market.

The inspection of canned tomatoes has been continued, and an improvement in the industry has been noted. Consideration also has been given to other canned foods, many of which have been found to be adulterated on account of imperfect methods of manufacture. A large number of shipments of cottonseed meal were found to have a protein content materially less than that declared upon the label, and appropriate action was taken.

SHERLEY AMENDMENT.

Special attention has been given during the last two years to the enforcement of the Sherley amendment. The amendment declares drugs to be misbranded if their labels contain false and fraudulent

statements concerning their curative or therapeutic effects. A large number of criminal prosecutions have been successfully concluded and many cases are pending. A systematic plan has been developed for dealing with this problem, and already an improvement in the labeling of the medicinal preparations has resulted. Concerted efforts have been directed against spurious and adulterated drugs.

NUMBER OF CASES.

During the past three years the bureau has collected and analyzed at least 22,000 samples of domestic foods and drugs. It has afforded formal hearings to more than 9,000 manufacturers and shippers, and has sent to the Department of Justice, through the Solicitor, about 2,250 cases. Approximately 3,000 cases have been finally disposed of by the courts, the great majority having been uncontested and practically all those contested having been decided in favor of the Government. During the same period about 50,000 importations have been sampled, of which approximately 3,000 were refused entry, and 15,000 were admitted only after relabeling to conform to the provisions of the law.

RESEARCH AND EDUCATIONAL WORK.

During the past three years the research work of the Bureau of Chemistry, which previously had been confined largely to problems arising in connection with law enforcement, was extended to include work designed to prevent spoilage and waste, to increase production, and to develop new methods of utilizing products of the soil and sea. Investigations in the utilization and transportation of sea foods have resulted in a marked improvement in the canning of American sardines. Means also have been found to utilize the waste of this industry as an animal feed. Important improvements in the transportation of fresh shrimp and the shipment of fish under refrigeration have been made. Studies of the transportation and marketing of poultry and eggs have made possible the elimination of much waste due to decomposition resulting from faulty methods of packing and shipping. A process has been introduced for the manufacture of table salt which eliminates from it a poisonous ingredient formerly present in the salt obtained in certain sections. Important improvements also have been made in the processes involved in the

manufacture of gelatin, sauerkraut, maple and sorghum sirups, cider, fruit juices and sirups, citric acid, lemon oil, jams, jellies, marmalade, preserves, corn meal, and stock feeds.

Much important work has been done in the application of the principles of physical chemistry to the study of a large series of food products. The work upon the chemistry of sugars is recognized universally as of fundamental importance. A study of the composition of vegetable proteins has been begun and already has yielded results which are certain to be of value in the feeding and fattening of farm animals.

STANDARDS FOR FOODS AND DRUGS.

Experience in connection with the administration of the Food and Drugs Act has strikingly emphasized the importance of enforceable standards for foods and drugs. Without them it is impossible to carry out completely the purposes of the act. In many instances protection of the consumer—the principal object of the law—can not fully be accomplished, nor can unfair practices on the part of unscrupulous manufacturers adequately be prevented. In some cases maintenance of prosecution is difficult and expensive, even when the articles involved clearly are adulterated or misbranded. To meet this situation, I have recommended in the estimates for the fiscal year 1918 that the Secretary of Agriculture be authorized to establish standards of strength, quality, or purity for articles of food and for those articles of drugs which are sold under or by a name not recognized in the United States Pharmacopœia or National Formulary. The suggestion provides that if any article fails to conform to the established standards it shall be deemed to be misbranded, unless it is labeled so as plainly and conspicuously to show how it differs from the standard.

The adoption of legally enforceable standards will benefit both the consumer and the honest manufacturer. They will give consumers exact information as to the quality of food and drug products and will enable manufacturers to produce articles which will meet the requirements of the act, putting competition on a fairer basis. They will be of great assistance to Federal and State officials in the enforcement of food and drug laws and will tend to promote uniformity among the various States.

INSPECTION OF ESTABLISHMENTS.

I have also recommended in the estimates that the department be given authority to inspect establishments producing foods or drugs intended for shipment in interstate or foreign commerce. No specific authority exists at the present time. While many manufacturers do not object to inspection of their factories, the lack of definite authority has caused considerable embarrassment in the enforcement of the Food and Drugs Act. There are many forms of adulteration which are exceedingly difficult to detect without inspection of the place of manufacture. This is particularly true of foods produced under insanitary conditions. In many instances it is impossible to determine from a chemical or bacteriological examination the conditions under which a particular food or drug was produced. It is unnecessary to emphasize the importance of sanitation in the preparation of food products. If the suggested authority be granted, the department should be able to improve the quality of food products, both by bringing to the attention of manufacturers any insanitary conditions that may be discovered and by securing evidence of production under insanitary conditions.

ROAD DEVELOPMENT.

The Office of Public Roads and Rural Engineering has extended its work of giving assistance in road and farm engineering problems to individuals or local communities in every State of the Union. There also has been placed upon it the burden of administering the Federal Aid Road Act. Immediately after the approval of the act plans were formulated for its administration. The appropriation of \$5,000,000 for the fiscal year 1917, after deducting an amount sufficient for administrative expenses, was apportioned among the various States on the basis of three factors—population, area, and mileage of rural delivery and star routes—each factor having a weight of one-third. Rules and regulations were promulgated on September 1, 1916.

Thirty-two States have indicated their intention to assent to the provisions of the act—one through its legislature and the others through their governors. Before the department can undertake cooperation in any State, it is necessary to determine (1) whether the State has a legally constituted highway department within the

meaning of the act and (2) whether the State has legally assented to the provisions of the act and is in a position to submit a program or scheme of work covering the five-year period and to meet the requirements of the act as to funds and maintenance of the roads constructed. This determination has been made in the case of nine States and, after certain details have been arranged, the department will be prepared to cooperate with all of them. Three States will await action by their legislatures before assenting to the provisions of the act. Tentative drafts of bills providing for State highway commissions have been prepared for two States which do not now have a highway agency within the meaning of the act. Eight States have submitted specific projects for consideration. In one of these States four projects have been approved tentatively and the necessary project agreements are in the course of execution.

The appropriation of \$1,000,000 provided by section 8 of the act for the construction of roads and trails within or partly within the National Forests has been apportioned among the various States in which National Forests are located. Applications for the construction of roads in the Forests must be filed in the district office of the Forest Service for the district within which the proposed road is located. In States having highway departments the applications, before filing, must be referred to them for recommendation. Many applications have been submitted to the district offices and now are under consideration.

THE NATIONAL FOREST ENTERPRISE.

There have been many important developments—legislative and administrative—during the past year in connection with the National Forests. The value of the properties to the public and the use made of them increased steadily. Their returns to the Treasury last year, exceeding \$2,800,000—an advance of more than \$340,000 over the previous year, are only a partial indication of their service. The land classification work, having for its object the determination of the areas which permanently should be included in the Forests, progressed very rapidly. As a result there remained in public ownership at the close of the year 155,420,280 acres, several million acres having been restored to the public domain or opened to entry under the Forest Homestead law. There was a marked increase in the equipment of the Forests with roads, a matter of prime importance for

the advancement of local community welfare and of no small importance for the economic development of the Forests themselves. An augmented volume of business, due to a larger number of timber purchasers, and a net addition of nearly three-fourths of a million to the number of stock grazed, together with a decided stimulus in prospecting and mining activities and in the use of the Forests for recreation and health, are further indications of broadening development.

PERMANENCE OF THE FORESTS.

Thus year by year the National Forest enterprise gains stability. In the long run the only means by which it can become stable is successful administration. Laws alone can not make it so. For a time the Forests were a great experiment. Whether the public benefits which their establishment had in view could be realized without accompanying intolerable drawbacks could be ascertained only through demonstration. An essentially constructive task was involved. The responsibility upon this department since it was placed in charge of the Forests has not been merely the routine discharge of definitely prescribed duties. It has been necessary to devise and apply methods for attaining broad general purposes embodied in laws by Congress. A vast land area was to be managed with a view to the most general, varied, and harmonious use. If these resources had not been made available to the public, a resistless demand for the abandonment of the project would have arisen. Through successful administration the permanence of the National Forests is becoming more and more assured. They are now a vital part of the economic life of the regions which use their resources. It is increasingly clear that National supervision and control of them is necessary and that they could not be abandoned without disastrous consequences to western industries and to local welfare.

ROAD DEVELOPMENT IN FORESTS.

In my reports of the last two years the need for more ample provision for road development in the National Forests was emphasized. Many of the Forests are located in the more remote portions of the western mountains. Roads are necessary for their protection, administration, and development. They are essential also for the upbuilding of the local communities. They are needed to open up

agricultural regions which now are practically shut off from the market, to make possible the development of mines and to stimulate prospecting, to shorten the distances of travel between localities and through the States, to make accessible wood and timber required for local use and for the lumber industry, and to enable the public to visit and enjoy the Forests for recreation and health. At the last session of Congress this urgent need received recognition through the enactment of the Federal Aid Road Act. An appropriation of \$10,000,000, to become available at the rate of \$1,000,000 each year, was made. This legislation constitutes one of the most important and far-reaching steps in National Forest development which has been taken for a long time.

EASTERN FORESTS.

By making provision for the continued purchase of forest lands in the East, Congress once more has recognized the permanence of the National Forest policy. Three million dollars, expendable during the fiscal years 1917 and 1918, has been made available for this work. The purchase of lands in the Appalachian and White Mountains, with a view primarily to the control of stream flow affecting the navigability of rivers, began in 1911. Under the provisions of the Weeks Forestry Act there have been approved for purchase 1,396,367 acres, at an average cost of \$5.22 per acre. The lands are in excellent condition and have been secured at very reasonable prices. These newly established Forests already are rendering important public service and are being used extensively. There is a marked demand for the timber upon them. The timber is cut in accordance with sound forestry practice. The White Mountain Forest in a short time should return to the Government as much as it costs to protect and administer it.

EXCHANGE OF LANDS.

Legislative advance also has been made in the approval by Congress of several important land exchanges. There are within the National Forests some private lands which are so intimately interlocked with Government lands as to embarrass protection and administration. At the last session of Congress authority was granted for the consolidation of Government holdings through exchange with private owners whose lands are within the boundaries of the Florida National Forest and within two of the Forests in the State

of Oregon. These exchanges always are made on the basis of equal value and are greatly to the interest of the Government for the permanent development of the National property. The department for several years has been working with a number of the Western States to effect a consolidation, by exchange, of school lands scattered through the Forests. In South Dakota the exchange has been partially completed, while in Idaho and Montana all the details have been agreed upon. Congress appropriated special funds for this work in Montana and Washington. Further authority is required to clear away certain legal difficulties and to permit final action. It is hoped that the measure now before Congress to secure this end will be approved.

PROGRESS IN ADMINISTRATION.

The progress made last year, both in new legislation and in the actual work of administering the Forests, is simply a continuation of the advance which has characterized each successive recent year. The public investment in its Forest work has become greater through reforestation, extensive additions to the permanent improvements, betterment of forest and range conditions resulting from the application of sound methods of management, and, perhaps most important of all, great progress toward final determination of the areas to be permanently held by the Government. Boundary rectifications since March 4, 1913, have eliminated from the Forests a total of 11,028,114 acres. The permanent retention of these areas was found to be undesirable either because of their character or because the Government holdings were too scattered for economical and efficient management. In the same period more than 886,000 acres have been opened to settlement under the Forest Homestead Act.

UNWISE LEGISLATION.

Millions of dollars, appropriated by Congress for the improvement, development, and consolidation of the Forest holdings have gone into the properties. Only on the assumption that the Forests are to be permanent would expenditures of this character be justifiable. Abandonment of the work after it has been carried to its present point would be a stultifying course. Nevertheless, repeated efforts in this direction still are made. Measures of various kinds, which, if adopted, seriously would injure or even render ineffective

the whole National Forest enterprise, are urged. The proposal that the properties be turned over in their entirety to the several States has a waning support and no longer needs to be taken seriously. On the other hand, efforts frequently are made to secure the abolition of individual Forests. Proposals to do away with the Forests in Alaska still find strong advocates. As pointed out in my last report, such action would be unwise and unfortunate. Action of this sort, however, can be met squarely on its merits, for the question of abolishing a National Forest raises a clear-cut issue which the public can not misunderstand.

A more serious danger to the National Forest system lies in the repeated efforts to open them to the action of some general land grant or to the laws applicable to the unreserved public domain. Each year there are introduced in Congress numerous proposals designed to open the Forests, or portions of them, to private acquisition or to disposition of one kind or another. One measure of this character passed both Houses of Congress during the last session and failed to become law only through the Presidential veto. It proposed to open the Forests to the acquisition of lands by any incorporated city or town for park and cemetery purposes and to counties for park purposes. Every public purpose of the proposed measure can be realized under existing law. So serious would be the effect of such a measure that, if enacted, undoubtedly it would be necessary within a few years actually to abandon a number of important Forests. In his veto message, after explaining that the measure was entirely unnecessary and would have unfortunate public consequences, the President said:

But the most serious objection to the bill is that it subjects the National Forests to disposition under a general grant. At the very time while provision is being made for purchase by the Government of forested lands in the East for the protection of watersheds, it is proposed to permit similar lands in the West to be permanently alienated. I would respectfully urge that it is unwise to permit alienation of the National Forests under general legislation of this sort. If the process of piecemeal distribution is begun, independently of any oversight or control of the National Government, there is manifest danger that the Forests will be so disintegrated as to make their efficient administration impossible and the purposes for which they were established unattainable. Against such a process the National Forests should be carefully protected.

RECREATION USE OF THE FORESTS.

The use of the National Forests for recreation purposes continues to extend. This important aspect of forest utilization was discussed at length in my last report. It is not necessary again to enlarge upon it. As the upbuilding of the West goes on and cities and towns increase in number and size, provision for community needs along what may be called park lines increasingly will become a part of National Forest administration. Thousands of local recreation centers, public picnic and camping grounds, excursion points, and amusement resorts are being developed in places readily reached by large numbers of people, as well as at the innumerable lakes, mineral and hot springs, other marvels of nature, and spots of scenic beauty with which the mountains abound. Many of these places will attract visitors from distant parts of the country and will become widely known. Some of the areas, located near enough to cities and towns to be reached by considerable numbers of persons, serve already the purposes of municipal recreation grounds and public parks. To meet local needs along this line the department is cooperating with municipalities. It welcomes opportunities for cooperation in this direction, just as it does in the protection of Forest watersheds from which municipal water supplies are derived. These forms of public service can be rendered without difficulty in connection with the fulfillment of the general purposes of the Forests.

NATIONAL FORESTS AND NATIONAL PARKS.

The handling of the National Forest recreation resources inevitably raises the question of the relation of the National Forests and the National Parks. At present there is no clear distinction in the public mind between the two. Both are administered for the benefit of the public along lines which overlap. The Parks and Forests occur side by side and have the same general physical characteristics—extensive areas of wild and rugged lands, for the most part timbered, with development conditioned upon road construction and similar provisions for public use. They differ chiefly in the fact that the attractions of the National Parks from the recreational standpoint are more notable. Yet this is not always true. Several of the Parks are inferior in their natural features to portions of the

Forests. The need of drawing a clear distinction between National Parks and National Forests and of a definite policy governing their relation is increasingly evident. Parks are being advocated where the land should stay in the Forests, while elsewhere areas which should be made Parks continue to be administered as Forests—for example, the Grand Canyon of the Colorado.

A National Park should be created only where there are scenic features of such outstanding importance for beauty or as natural marvels that they merit National recognition and protection and, on this account, have a public value transcending that of any material resources on the same land—such areas, for example, as those now comprised in the Yellowstone and Yosemite Parks and in the Grand Canyon National Monument. The areas should be large enough to justify administration separate from the Forests and the boundaries drawn so as not to include timber, grazing, or other resources the economic use of which is essential to the upbuilding and industrial welfare of the country. In addition, when Parks are created from parts of the Forests, the portions remaining as Forests should not be left in a form difficult or impossible to administer.

CLEAR-CUT POLICY NECESSARY.

The importance of a clear-cut policy is evidenced by the efforts frequently made to secure the creation of National Parks out of areas containing great bodies of timber, extensive grazing lands, and other resources, the withdrawal of which from use would be uneconomic and prejudicial to the local and general public interest. In most cases the desire for a specific Park, where economic use of the resources also is essential, has led to the proposal for an administration of the area, after the creation of the Park, identical with the present Forest administration. Several such measures now are before Congress. Their enactment would result in a mere division of the public properties into Parks and Forests, having no distinction except in name; handled alike, but by duplicate organizations in different departments. Still more serious is the fact that the cutting up of the Forests would greatly cripple administration of the remaining lands. It would doubtless mean the abandonment of large areas which should remain under public ownership and control for timber production and watershed protection. It would greatly reduce efficiency in forest fire protection and in the handling of current business, increase the expense

of protection and administration, and cause endless confusion to users, who in many cases would have to deal with two departments in developing resources when, for instance, logging and grazing units overlap.

The protection of the scenic features and the development of the recreational use of the lands is being taken care of in the National Forests. Some of the most unusual scenic areas in the Forests are best suited to a full Park administration. The bulk of the Forest areas, however, should continue in their present status, where they will be fully protected and developed for recreation purposes as a part of the Forest administration. The extensive road building, made possible by the \$10,000,000 recently appropriated, will open them up rapidly.

An added cause of confusion is the fact that National Parks and National Forests are administered by two executive departments. While there is an effort to cooperate, nevertheless difficulties arise which could be wholly avoided if they were under one department. Unquestionably the administration of the Forests should remain in the Department of Agriculture, because of the close relationship of the work of the Forest Service to the activities of other bureaus of the same department, such as the Bureau of Plant Industry, Bureau of Animal Industry, Office of Public Roads and Rural Engineering, Bureau of Soils, Bureau of Biological Survey, and the Bureau of Entomology. Obviously, there are in the Forests many problems relating to live stock, plant growth, predatory animal and insect control, soil conditions, and road and trail work. These great bureaus are directly and intimately concerned with these problems. If the Forests were transferred to another department, that department either would have to duplicate these bureaus in part, or would have all the difficulties of cooperation with another department which seem to be inherent. Whether the National Park Service should be transferred to the Department of Agriculture is a matter for consideration. If the transfer should be made, it would be unnecessary and, in my judgment, unwise to consolidate the work of the two services. The Park Service should take its place in the organization of the department as an independent bureau, with its activities closely related to those of the Forest Service. Certainly, if the two services are to be administered by different departments,

there should be the closest cooperation throughout. Such cooperation should include not only the question of the creation of new parks out of National Forests, but also fire protection on contiguous properties, game preservation, road building, and other activities.

Respectfully,

D. F. HOUSTON,
Secretary of Agriculture.

THE PRESIDENT.

REPORTS OF CHIEFS.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

UNITED STATES DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
OFFICE OF THE CHIEF,
Washington D. C., October 14, 1916.

SIR: I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year ended June 30, 1916.

Respectfully,

C. F. MARVIN,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

The service of the Weather Bureau to the country for the past year has been fully and effectively maintained at practically the same annual expenditure as in the preceding year. Throughout the crop-growing season and over the great agricultural, horticultural, and citrus regions of the country the weather was generally favorable after July of last year. Less favorable conditions marked the first half of the growing season of 1916, and a number of important crops have suffered.

In August and September the Gulf region was visited by two very destructive West Indian hurricanes, causing great property losses, especially in Texas and Louisiana, but the wide dissemination of timely warnings of these storms by the bureau was doubtless the means of saving many lives and safeguarding property interests as well.

Some details of the work of the bureau are outlined under a series of captions, as follows:

STATIONS AND OBSERVATIONS.

Few changes of consequence have been made in the principal stations of the service, which now number 199. These stations furnish the principal telegraphic reports upon which the weather forecasting is based. Supplementary or substations are also maintained at over 4,500 points where the activities are carried on upon a cooperative basis. New cooperative stations are constantly being established, especially in new and sparsely settled regions from which observations have been previously unobtainable.

New Federal buildings were occupied during the past year for offices at Denver, Colo.; Pocatello, Idaho; Thomasville, Ga.; Williston, N. Dak., and Wytheville, Va. The Weather Bureau stations at these points were moved to quarters therein from rented offices.

Local conditions and facilities having changed at the station at Port Crescent, Wash., the Weather Bureau station was removed on February 29, 1916, to Port Angeles, Wash., a thriving town about 20 miles to the eastward. The Weather Bureau telegraph line extending from Tatoosh Island, Wash., to Port Crescent, Wash., was thereupon extended to Port Angeles, by the purchase from the Western Union Telegraph Co. of wire and poles already in place and in good condition. This seacoast telegraph line enables the bureau to maintain continuous communication between the important station of Tatoosh Island and the station at Port Angeles, which became the new eastern terminus of the Weather Bureau line on March 1, 1916.

A new telegraph office and cottage building authorized during the previous fiscal year was completed at Neah Bay, Wash., October 1, 1915. This building affords comfortable living quarters for the repairman of the Port Angeles-Tatoosh telegraph line stationed there and office for the telegraph business of the Government handled at that place. Necessary improvements were effected at Tatoosh Island station, where tanks for storage of rain water, required for drinking and culinary purposes were provided. No other source of supply is available on the island.

All Weather Bureau buildings, of which there are now 46, were maintained in good, serviceable condition by repainting and repairing wherever needed for proper upkeep.

An effort was made to ascertain whether the buildings and property of the Weather Bureau at Mount Weather, Va., could be utilized by any other branch of the Government, with the result that the Public Health Service, Treasury Department, after investigation, contemplated using the buildings and property as a sanatorium. House bill 13672, introduced by Mr. Carlin March 24, 1916, provided for the transfer and necessary alteration of the property. It has recently been learned, however, that this project has been abandoned or deferred.

Suit of The United States v. The Northern Pacific Railway Co. to quiet title to land at Bismarck, N. Dak., formerly used as a military post and occupied as a Weather Bureau station since June 1, 1894, was set for trial at the June, 1916, session of the United States district court of North Dakota. Before the case came to trial, however, a compromise was offered, which was accepted by the Attorney General of the United States. This compromise is in effect as follows:

Northern Pacific Railway Co. quitclaims to Government rights to property north of tracks, railway company to have property south of tracks for yards and sidetracks and reimburse Government for improvements thereon.

A saving of about \$600 per annum was effected in the arrangements for rented quarters and roof exposures at 5 of the stations in the West Indies.

EXAMINATION OF METEOROLOGICAL FORMS.

Careful examination of the important meteorological forms rendered by the regular station force, as well as those from the large corps of cooperative observers and painstaking efforts to make instructions as definite as possible, have resulted in a general lessening of the number of occasional errors detected in the statistical reports of meteorological data.

COOPERATIVE STATIONS.

The experience of the past year in working up the large amount of data required for the proposed Atlas of American Agriculture has demonstrated the excellent character of the work of the cooperative observers, who perform their simple but important duties without compensation. In fact, the records indicate that the observations made by the men and women who make up the list of cooperative observers are as correct and trustworthy as possible under the circumstances.

INSPECTING COOPERATIVE STATIONS.

The policy of frequent inspection of cooperative stations has been adhered to during the past year, and many necessary inspections were made by a number of the State section officials. These inspections are especially helpful in bringing to light defects in instrumental equipment or observational work, and afford opportunity for the bureau to indicate its appreciation of the valuable service rendered the public by these faithful observers.

SNOW BULLETINS.

During the past winter effort was made to increase the amount of information pertaining to the snow conditions in the far Western States, by securing a greater number of reports from the higher mountain districts. These additional reports will furnish an index to the character and amount of the snow in the regions where it remains unmelted until late in the season, and enable estimates to be made of the probable waterflow in the streams used for irrigation and power purposes.

SERVICE IN ALASKA.

The supervision of the climatological work in Alaska was assigned during the past year to the official in charge of the Washington State service at Seattle, and provision has been made for the publication of an annual summary of climatological data for that Territory for 1915, similar to those issued for the several States.

In view of the rapid development of Alaska, the appropriation act for the fiscal year 1917 provides funds for the establishment of a fully equipped weather bureau station at some central point in the Territory. This will also permit the development of a local weather service and the publication of a monthly bulletin for this region to meet the growing demands for climatic information.

OCEAN METEOROLOGY.

In general the work of the marine section has progressed along the usual lines. Owing to the effect of the war on ocean shipping the number of vessel reports received during the year has been largely below that of normal times, except from the Pacific Ocean. The examination and charting of reports received from the Atlantic Ocean have continued, and this work has been kept as nearly up to date as feasible.

It is considered highly desirable that reports received from the Pacific Ocean should be charted in the same manner as those of the Atlantic. Owing to the growth of shipping on the Pacific in recent years it has been possible for the bureau largely to increase the number of vessel reports from that ocean, so that the preparation of a synoptic chart is now believed to be warranted. Plans to accomplish this are now being formulated.

The extension of work in the Pacific Ocean has a two fold purpose. Not only is it designed to throw light on coming weather in the United States—weather changes, as is well known, moving from west to east—but it is in line with a concerted and widespread movement in all branches of science to inaugurate a special study of the Pacific, with the object of adding to the world's general knowledge of this vast area.

During the last hurricane season, extending from July to November, many valuable reports were received by wireless from the special service maintained on vessels traversing the West Indian waters and the Gulf of Mexico, enabling the forecasters to determine accurately the position, direction of movement, and rate of progress of the severe storms that reach the mainland of the United States from those regions.

HYDROLOGIC WORK IN SOUTHERN CALIFORNIA.

Preliminary action has been taken looking toward the establishment of a river district center at Los Angeles, Cal., for the purpose of giving such notice as may be possible of the coming of destructive floods which issue from the mountains of Los Angeles and San Bernardino Counties during the prevalence of heavy and continuous rains. Cooperative rainfall observations at 12 points in the mountains of Los Angeles County were begun in January, 1916.

In connection with this subject and closely related thereto, the bureau has undertaken, in cooperation with the Forest Service, to carry on a series of rainfall measurements in the Los Angeles National Forest. The chief contracting parties to the cooperation are the board of supervisors of Los Angeles County on the one hand and the Forest Service of the Department of Agriculture on the other hand, the latter representing such other branches of the Federal Government as are contributing to the work.

MEASUREMENT OF PRECIPITATION AT HIGH ALTITUDES.

This work, begun in 1909, in Pacific coast, plateau, and Rocky Mountain States, has been continued during the year at about 180 stations. Intensive measurements of snow depths and densities at the beginning of the melting season have been made in limited regions

on the watershed of Cottonwood Creek, a tributary of the Boise River of Idaho, in the Paradise Creek Valley, on the headwaters of the White River in Arizona, on the watershed of City Creek, near Salt Lake City, Utah, and in the watershed of Lake Tahoe, Nev. In the last named the measurements were made in cooperation with the agricultural experiment station of Nevada, at Reno. From the nature of the case, intensive measurements of snow depth and density can not be made on any considerable portion of the snow fields of high altitudes; in fact, grave difficulties are encountered at altitudes between 8,000 and 10,000 feet. The purpose of the bureau in the matter has been to develop methods and apparatus whereby the measurements can be made quickly, and to demonstrate the practical utility of the work by actual surveys over portions of small watersheds, whence comes the water supply of residents of the lowlands below. A case in point is that of Salt Lake City, Utah, where the water supply is drawn from the Wasatch Mountains to the eastward. In summer, in the absence of sufficient rainfall, the flow of the mountain streams is almost wholly derived from the melting of the winter's snowfall. The usefulness of the method has been so clearly shown to the officials of Salt Lake City for several years past that they have independently conducted a survey over one of the larger watersheds and have aided the bureau on a survey in one of the smaller watersheds which contribute to the water supply of the city. Aside from the importance of these snow surveys from a practical point of view, they also contribute indirectly to our knowledge of the relation which exists between the fundamental phenomena of precipitation and run-off.

LIGHTSHIP WEATHER STATIONS.

Through the cooperation of the Bureau of Lighthouses, Department of Commerce, there has been introduced an entirely new class of weather stations aboard lightships equipped with wireless apparatus. These stations will report upon weather conditions by wireless twice each day. Each will be equipped for measuring pressure, temperature, and wind velocity. At Frying Pan Shoals both the regular and relief vessels have been equipped, but reports have not yet been received. At Nantucket Shoals one ship has been equipped, but reports have not yet been rendered. Plans are under way for equipping the Heald Bank light vessel in the near future.

EVAPORATION WORK.

Although the demand for the installation of evaporation stations has increased, the introduction of class A stations has progressed rather slowly, because the funds for purchasing equipment and the facilities for administration are not considered equal to a rapid extension of this work. Eight stations have been equipped and are now rendering monthly reports.

STORM-WARNING STATIONS.

The storm-warning stations of the bureau on June 30, 1916, were as follows:

Paid stations, 191, a decrease of 2 during the year.

Cooperative stations, 113, a decrease of 4 during the year.

Weather bureau stations displaying storm warnings, 60, the same as last year.

A system consisting of three lights in a vertical line to signal by night the same information concerning storms now furnished by day has been installed on the Great Lakes, only 3 stations remaining to be completed. In connection with this work new electric lamps of increased brightness and a standardized system of wiring in conduit have been installed. Stations on the Great Lakes equipped with oil-burning lanterns have had a third lantern furnished, together with necessary means of display. Other improvements have consisted in the removal of towers to more favorable locations and the erection of new steel towers in a number of cases, with the object of placing the storm-warning equipment on the Great Lakes in first-class condition throughout.

TELEGRAPH SERVICE.

The commercial telegraph companies have continued their hearty cooperation with the bureau in maintaining service. Complaints of delays have generally received prompt and effective attention, with satisfactory results. Reports over all circuits are often sent and received and the circuits closed by 9 a. m., one hour after taking observations.

The contract for special operators' services employed at various Weather Bureau stations was found to be inconsistent as to the amount charged. A reorganization was effected in this feature of our work and will result in a decrease in cost of nearly \$900 per annum.

A further revision of several circuits was undertaken and put into operation May 1, 1916, by which a saving of over \$2,000 per annum will be effected; in addition to increasing the number of reports to several stations. Another revision of certain circuits during June will also effect a saving of over \$300 per annum and still give much-desired evening reports to certain stations.

WEATHER BUREAU SEACOAST TELEGRAPH AND CABLE LINES.

In all cases these are lines connecting outlying points of importance from a meteorological point of view with which no other means of communication are available for the transmission of reports. While these lines are maintained and owned by the Weather Bureau distinctly for its meteorological work, they nevertheless have come to carry a considerable amount of commercial business which brings in a small revenue. Lines are maintained in the following sections:

Block Island-Narragansett.
Mount Weather-Bluemont.
Norfolk-Hatteras.
Key West-Sand Key.
Glen Haven-South and North Manitou Island.
Alpena-Middle Island-Thunder Bay Island.
Grand Marais-Whitefish Point.
Beaver Island.
Tatoosh-Port Angeles.
North Head.
San Francisco-Point Reyes.

The increased importance of coastal communication to the operations of the Government is fully recognized, and every effort has been made to maintain the lines in the charge of the Weather Bureau in an efficient condition of repair and operation. As maintenance expenditures on these lines have been maintained at the minimum in former years, rather extensive repairs have been necessary in some instances. Nevertheless, a careful accounting of revenue and repair cost still shows a small balance in receipts over costs of repairs amounting to \$287.83 on an income of \$5,654.

FORECASTS AND WARNINGS.

DISTRIBUTION OF WEATHER FORECASTS.

The distribution of weather forecasts has been continued along the same lines as in former years and by the same methods, i. e., by telegraph, by telephone, by mail, and by wireless. The daily forecasts are available by telephone to more than 5,000,000 subscribers, and by mail to more than 100,000 addresses. Distribution by wireless has been somewhat extended during the year. By this means the forecasts for nine States are distributed from four points. Those for North Dakota, South Dakota, and Minnesota are broadcasted from University (Grand Forks, N. Dak.); for Illinois, from Springfield, Ill.; for Ohio, from Ohio State University, Columbus, Ohio; for Iowa, Kansas, Missouri, and Wisconsin, from the United States Naval Training Station, Great Lakes, Ill. These forecast messages are received at about 270 amateur radio stations. A further extension of the distribution may be expected through the issue of forecast cards by the wireless operators. This feature of the matter has been given consideration, but the results are not yet determined.

SPECIAL FORECASTS.

Special forecasts for the benefit of the alfalfa crop during the harvesting season were inaugurated, and in order to meet the needs of these interests forecasters were authorized to extend the period covered by the forecasts beyond the regular 36 and 48 hour periods provided for in instructions.

WEEKLY FORECASTS.

The day of issue of the weekly forecasts was changed from Tuesday to Saturday, so that at present these forecasts cover the ensuing calendar week.

NIGHT FORECASTS.

The issue of night forecasts was begun at the New Orleans, La., forecast district center. Both night and morning forecasts for the respective districts are now issued at each district center.

EXTENSION OF THE METEOROLOGICAL SERVICE IN THE WEST INDIES.

Arrangements are being made for the extension of the meteorological service in the West Indies, the Caribbean Sea, and the Panama Canal, in order to make more efficient the issue of storm advices for the southern waters of the United States.

SEVERE STORMS.

Two tropical storms, originating in the Caribbean Sea in August and September, 1915, and moving northwestward to the Gulf coast, developed unusual intensity and occasioned great loss of life and immense destruction of property. The first of these passed over Galveston and Houston, Tex., August 16 and 17, the barometer falling to 28.20 inches at Houston and the wind reaching a maximum velocity of 93 miles per hour from the east at Galveston. It was estimated that about 280 lives were lost and property amounting to \$20,000,000 destroyed. The second struck the coast about the mouth of the Mississippi on September 29 and passed northward over New Orleans, La. The barometer fell to 28.11 inches at New Orleans, the lowest reading on record in the United States, and the wind attained a maximum velocity of 130 miles per hour from the east. The estimated number of lives lost was 275 and the value of property destroyed \$13,000,000. Warnings of these storms issued by the Weather Bureau, beginning with the first day of their appearance, were given widespread and effective distribution well in advance, and were without doubt the means of great savings, both in life and property.

RIVER AND FLOOD SERVICE.

Sixty-two of the principal stations of the bureau participate in the work, and about 600 subordinate river-gaging and rainfall-reporting stations furnish the necessary hydrologic data for the respective watersheds. Flood warnings and all forecasts of river stages are issued by trained section officials specifically authorized to do so, but all this work is rather closely supervised at Washington, in the belief that constant oversight is necessary and helpful in maintaining the service at a high standard of efficiency.

The severe floods of January and February, 1916, in the Mississippi below Cairo, in the rivers of Arkansas and Oklahoma, and, later in the year, in the Mississippi between Dubuque, Iowa, and Louisiana, Mo., afforded a critical test of the efficiency of the organization. As the flood crest on each stream approached, timely and accurate warnings thereof were distributed well in advance. The present system of flood forecasting is the result of about 10 years of well-sustained effort on the part of river forecasters to improve the warnings and to get a better grasp upon the problem.

LOSS AND DAMAGE BY FLOOD.

A compilation of the loss sustained in the United States during the calendar year 1915, due to flood waters, places the amount at nearly \$21,000,000. Of this amount a little more than half fell upon the agricultural interests of the country.

AGRICULTURAL METEOROLOGY.

From the early days of the service the issue of frost warnings for the special benefit of gardeners and horticulturists, and the citrus, the tobacco, the cranberry, and other industries, has been marked by constant study, improvement, and extension. With the advent of arti-

ficial methods of orchard heating and the more or less successful protection of extensive areas from frost injuries by smudging and other means, a great demand has been created for frost forecasts and warnings. Similarly, for many years the Weather Bureau has maintained during the crop-growing season a special service of weather reports and the prompt issue of bulletins relating to conditions throughout the great grain, cotton, and agricultural and stock regions of the country generally. A number of studies have also been conducted, especially of late years, to discover and formulate the relations between weather and crops and the character and amount of the influence of weather on production.

With economies of administration in all lines of our work and without specific increase of funds it became possible during the past year to reorganize and bring together all this work into a new division, designated "Division of Agricultural Meteorology." While a number of new lines of work will be undertaken in this new division, the bulk of its work at the present time comprises former activities now brought together, coordinated, and improved.

It seems opportune to outline briefly the scope and purposes of agricultural meteorology as now organized in the Weather Bureau.

DIVISION OF AGRICULTURAL METEOROLOGY.

This new division was organized February 21, 1916, under the supervision of Prof. J. Warren Smith, for the purpose of conducting studies of every character of the relation of weather to crops and the collection of statistical data required in such studies, including the direction and supervision of cooperative relations with the State experiment stations and other contributing organizations. The division is to conduct investigations of the effect of weather and climate upon the growth and yield of crops and will control the distribution of frost warnings and forecasts to special agricultural interests, conduct studies for the protection of crops and orchards from frosts, and, in general, supervise the activities of the Weather Bureau which relate to agriculture and which are comprised in a number of special services briefly mentioned and described in the following:

CORN AND WHEAT REGION SERVICE.

This service covers the 16 principal grain States, and its organization includes 1 region center and 13 district centers, with 168 special stations from which telegrams are received daily. Daily bulletins showing the temperature and rainfall at these stations are published at 18 different points, with a total daily issue of 2,775 copies. This service was reorganized during the spring of 1916 by the establishment of a region center at Chicago, making the districts conform to State lines so far as possible, the establishment of new district centers in Montana, North Dakota, and South Dakota, and the extension of observational stations into the new grain regions of the Northwest, as well as into some of the uncovered grain districts in the Central States. This was accomplished by the establishment of 14 new corn and wheat stations. Data covering the rainfall at each of the 168 stations and temperature at 5 stations in each State are telegraphed to the region center at Chicago each morning, and, after

being charted and tabulated, a summary covering the weather conditions throughout the corn and wheat regions is telegraphed to 18 different points and there published in the form of daily bulletins, besides being given to the press.

COTTON REGION SERVICE.

This service covers the 11 principal cotton States, and consists of 1 region center and 15 district centers, and has 166 special stations. Daily records of temperature and rainfall are telegraphed from these special stations in each district to the district center, and at these centers and 11 other points daily bulletins are published, with an issue of 1,736 copies. Weekly bulletins and charts giving the temperature and rainfall over the cotton States are also published at New Orleans. This service was expanded during the spring of 1916 by the extension into the new cotton-growing district in western Texas and other uncovered fields. Preliminary work was started to reorganize this service along State lines, but it was thought best to delay the change until the season of 1917.

SUGAR AND RICE REGION SERVICE.

This service covers the rice-growing region of Texas and Louisiana, and the sugar district of the Southern States. No material change was made during the year just ended. However, correspondence has been under way looking to the extension of the rice-region service.

SPECIAL FRUIT REGION SERVICE.

This service consists of several separate branches, consisting of the cranberry service in eastern Massachusetts and southern Wisconsin, investigations into temperature conditions at various elevations in the mountains in western North Carolina and in the Salt River Valley in Arizona, and special forecasts and warnings for the benefit of fruit men who are protecting their orchard crops from spring frosts in Ohio, Colorado, Utah, Idaho, Washington, Oregon, and California. This service has been expanded during the year by the establishment of seven new stations in the grape and peach-growing district of northern Ohio, by the extension of the special cranberry service in the Shell Lake district of southern Wisconsin, and by the detail of trained men for special duty in the fruit district in the Hood River Valley in Oregon and the Gunnison Valley in Colorado. These men studied the local situation and gave expert information to the fruit growers as to the temperature to be expected, and whether it would probably be necessary to prepare for lighting the fires in the orchards. These men proved to be of unusual benefit to the orchard growers in these valleys, and there is already a demand for the extension of this service into other districts where fruit is intensively grown and arrangements are made for protection of the orchards by heating. In Ohio this warning service is given by long-distance telephone from the section center at Columbus with considerable success, by a careful study of the temperature and weather records in each orchard where heating is carried on.

SPECIAL TOBACCO SERVICE.

This service is now carried on in the States of Connecticut and Wisconsin, with 2 district centers and 13 stations. No material change was made during the year in these States, but arrangements were completed for the establishment of a special tobacco service in the important tobacco districts in western Kentucky. In this State not only will warnings be issued for the tobacco growers at critical periods, but the general effect of the weather conditions upon the development of the tobacco will be studied through cooperation with the officials of the agricultural experiment stations.

SPECIAL CATTLE-REGION SERVICE.

This service at present has 1 district center at Amarillo, Tex., with 12 special stations, and receives reports from 9 other points in the cattle-range district of the Southwest. Daily bulletins are published giving the rainfall and temperature over the southwestern cattle ranges, with an issue of 625 copies. This service has been expanded somewhat during the year by receiving reports from a wider area. Preliminary steps have been completed for the establishment of a new cattle-region district center at Roswell, N. Mex.

SPECIAL ALFALFA SERVICE.

This service is maintained in Utah, with three special stations. There has been no change during the year. In addition, however, there has been an expansion of special three or four day forecasts for the benefit of alfalfa harvesters throughout the whole western part of the country during the present season. If fair weather is expected for three or four days, or if a rainy spell is in anticipation, this information is telegraphed from the district centers to the large alfalfa-growing points, where action is taken to disseminate the information for the benefit of the various alfalfa growers. The temperature forecasts will be issued in the same way in connection with the harvesting of alfalfa seed.

SPECIAL TEMPERATURE AND STORM WARNINGS FOR SHEEPMEN.

In the spring of 1916 special rain and temperature forecasts for the sheepmen in Oregon, Washington, and Idaho were made by the district forecaster at Portland, Oreg., during the shearing and lambing season. It is estimated that there are more than 6,000,000 sheep in these States. As winter feeding is expensive, sheep are usually shorn and put on the ranges as early as possible. Early lambing is encouraged also. Before being shorn, if stormy and cold weather prevails, the sheep may succumb to fatigue and starvation, and after being shorn it is necessary to keep the sheep near natural or artificial protection for a short period if unfavorable conditions prevail. The forecasts enable proper precautions to be taken by anticipating these conditions, and also give information as to favorable weather conditions for several days in advance, so that sheep may be grazed farther away from protection. During the spring of 1916 this information was telegraphed to 26 different points in these three States, and from them distributed by telephone to hundreds of sheepmen. The information has been found to be of very great importance, and the service will be continued and expanded.

COOPERATION AND INVESTIGATION.

Cooperation is going on between the Weather Bureau and other Government bureaus and departments in several different lines of activities. Among them will be noted the keeping of records of temperature, rainfall, and depth of snow, as well as the distribution of special forecasts and warnings by the officials of several other branches of the Government service. Among the most important are the following: (1) The publication of the monthly crop report at 40 different Weather Bureau stations in the United States for the Bureau of Crop Estimates. These reports cover the crop conditions in every State in the Union. No material change has been made during the year, although plans are in progress for improving these published reports by including a general statement of the weather conditions and a running statement of the crop conditions. (2) Cooperation with the Office of Markets and Rural Organization in the publication of daily market reports. This service was in operation from May 9 to June 12 at Chattanooga, Tenn., in connection with the strawberry crop. Market information was telegraphed to our official at Chattanooga and daily bulletins were prepared and issued at that office.

SPECIAL FRUIT STUDIES.

Studies are going on as to temperature variations at different altitudes in North Carolina, Oregon, Colorado, and Ohio, and investigations have been continued in connection with temperature and frost forecasts for the benefit of those fruit growers who are heating their orchards, and information has been gathered as to the value of these heaters and the expense of orchard protection. These matters are of very great importance, and it is hoped that funds will be in hand for a considerable extension of this investigation, particularly along the line of frost damage and the best heating methods.

Five sets of maximum and minimum thermometers have been furnished to the Bureau of Entomology for use in fruit orchards at Kanawha Station, Wood County, W. Va., in connection with the study of weather effects on the fruit trees and on the activities of damaging insects. This service was put into operation in May, 1916. Two full sets of instruments were also furnished to Prof. E. P. Felt, for use at Newfane, near Lockport, N. Y., and Kendal, near Albion, N. Y., to study the relation between the weather and the damage done by the codling moth. It is believed that the evening temperatures have an important influence upon the deposit of the eggs of this moth, and this investigation is to determine some facts regarding that matter. Four sets of instruments that had been in use in central Massachusetts by Prof. J. K. Shaw, of the College of Agriculture, at Amherst, Mass., in studying the weather conditions at different elevations and its effect upon the apple crop, were moved in the spring of 1916 to the Berkshire Hills in western Massachusetts, where a study was carried on to determine the connection between inversions in temperature in relation to the development of peach buds.

COOPERATION WITH EXPERIMENT STATIONS.

Correspondence was begun early in the season with the directors of all the agricultural experiment stations in the United States,

preliminary to cooperation to determine the critical period of crops and the weather that has the greatest effect on crop yields, as well as on the extent of insect and fungous damage. It is expected that a definite and extensive system for keeping regular records of the different weather factors and the development of the most important crops will be instituted at a large number of these stations, and such preliminary work started as may be continued through a series of years, and from which large results may be anticipated.

WEATHER AND CROP STUDIES.

The chief of this division, before his appointment to this position, had made studies to determine the critical period of growth of corn, potatoes, wheat, hay, fruit, and other crops by mathematical and graphical correlation methods, and the division is now continuing these studies as fast as the routine duties will allow. Some of the results of these investigations are appearing in the National Weather and Crop Bulletin that is prepared by this division and others will appear from time to time in various publications as the subject is developed. It is believed that it has remarkable possibilities for development for the benefit of the agricultural interests of the country.

NATIONAL WEATHER AND CROP BULLETIN.

The most important routine work of the division is the issue of the Weather and Crop Bulletin, which is published weekly during the summer months and monthly during the winter season. During the past year publication of the weather and crop diagram pages covering the weather and condition of cotton, corn, and wheat, started in 1915, was continued, but a change was made to allow the division of this territory into 12 diagrams instead of 7, thus making the areas smaller and the data more definite. Detailed studies have been printed to show the effect of rainfall and temperature upon crop conditions, and the knowledge gained in these and other similar studies has been applied in discussing the effect of current weather upon the development of crops. The regular publication of the weekly weather forecasts in the bulletin was discontinued in the spring of 1916, and since then any reference made therein to the forecasts has been in connection with the current weather conditions. The issue of this bulletin is 3,750 copies.

METEOROLOGICAL RECORDS AND PUBLICATIONS.

The several annual, monthly, and other serial publications of the bureau have been issued in regular sequence, and continue to supply the general and technical public with useful information.

On account of the large demands for climatic data from all portions of the country, it has been necessary to reprint several of the separate parts of Bulletin W and Climatological Data of the United States by Sections. Others are now ready for reprinting when opportunity offers. The growing demand for these summaries indicates that the entire set should be brought down to date and reprinted.

MARINE OBSERVATIONS.

The publication of the monthly summaries of weather conditions over the north Atlantic Ocean in the *Weather Review*, together with charts showing the averages of pressure and temperature, the prevailing direction of the winds, and the paths of the more important storms, begun during the early part of the year, has continued.

ATLAS.

Substantial progress was made during the year in the preparation of material for the Weather Bureau portion of the proposed Atlas of American Agriculture. Many of the more important charts have been prepared and are now in the hands of the draftsman for reduction to the final base size to be adopted, and it is expected the work will be very generally completed during the present fiscal year. Much work has been required of station officials in preparing the material for these charts, but this has resulted in the bringing together of a large volume of valuable material not previously summarized at stations.

ATMOSPHERIC MOISTURE.

Much material has been gathered in preparation of a report on the vapor pressure and relative humidity of the United States which it is hoped can be completed and published in the near future.

STUDY ON ANTICYCLONES OF THE UNITED STATES.

A study by Mr. E. H. Bowie and Mr. R. H. Weightman on the anticyclones of the United States and their average movements is nearing completion, and the manuscript has been submitted for publication.

TREATISE ON WEATHER FORECASTING.

A board consisting of Profs. A. J. Henry (chairman), H. J. Cox, and H. C. Frankenfield, and Mr. E. H. Bowie, have been engaged during the last year or so upon the preparation of a treatise or manual on weather forecasting in the United States. This important subject has never received the treatment that its importance deserves. Weather forecasts under governmental auspices have been made continuously for about 45 years, yet only fragmentary and scattered references to the general principles of the art have appeared in print. The manuscript and the illustrations were completed during the year and the matter is now in type, forming a printed volume of 370 royal octavo pages with 199 illustrations.

SUPPLEMENT.

A collection of phenological and meteorological observations at Wauseon, Ohio, mentioned in the report for last year, was issued as Supplement No. 2 on September 4, 1915.

PRINTING IN COOPERATION WITH THE BUREAU OF CROP ESTIMATES.

The printing of the monthly crop statistics furnished by the Bureau of Crop Estimates for the several States has continued as in past years, and no effort has been spared by our station officials to place the information in the hands of the public as early as possible.

PRINTING DIVISION.

The operations of the printing division have continued very much as heretofore, certain advantages having been realized from an extension of the floor space into area formerly utilized for storage purposes.

The following table shows the output of work for this division:

LITHOGRAPHIC.

	Copies.
Charts for Monthly Weather Review.....	184, 101
Charts for climatological data.....	684, 770
Hurricane charts.....	6, 200
Miscellaneous charts and maps.....	22, 525
Map A.....	57, 210
Daily Washington Weather Map.....	463, 125
National Weather and Crop Bulletin.....	110, 270
Snow and Ice Bulletin.....	23, 210
Blank forms.....	11, 800

PRINTING.

Station map bases (Forms DD, E, and CM).....	7, 620, 000
Daily forecast cards.....	472, 220
Weekly forecast.....	7, 615
Monthly Meteorological Summary.....	2, 520
Franking forecast cards for stations.....	19, 608, 900
Rural free-delivery slips.....	1, 707, 400
Covers for Climatological data.....	4, 980
Blank forms.....	2, 606, 190
Climatological data; Maryland, Delaware, and Virginia.....	23, 210
Letterheads.....	216, 200
Addressing envelopes.....	69, 950
Memorandum slips.....	142, 900
Skeleton letters.....	11, 300
Cards.....	47, 492
Instructions.....	17, 100
Weather Bureau topics and personnel.....	2, 800
Circulars and circular letters.....	19, 740
Station regulations and amendments, pages.....	53, 900
Labels.....	19, 000
Miscellaneous.....	126, 753
Binding Monthly Climatological Data, sets.....	4, 839
Flexotype work (4 months).....	3, 330

PERIODICAL PUBLICATIONS.

The daily, weekly, or monthly issues of our periodical publications at the close of the year were as follows:

	Copies.
Monthly Weather Review.....	1, 425
Monthly Climatological data for the United States.....	310
Washington Weather Map, first edition, (daily, except Sundays and holidays).....	990
Washington Weather Map, second edition (daily, except Sundays and holidays).....	440
Washington Weather Maps, Sundays and holidays.....	540

	Copies.
National Weather and Crop Bulletin (weekly from April to September, monthly from October to March)-----	3, 750
Snow and Ice Bulletin (weekly during the winter)-----	1, 110
Forecast cards (daily, except Sundays and holidays)-----	1, 550
Weekly forecasts-----	240
Monthly Meteorological Summary for Washington, D. C.-----	250

The distribution of periodical publications to foreign countries through the international exchange service and by mail was as follows:

	Addresses.
Washington Weather Map-----	83
Monthly Weather Review-----	376
Monthly Climatological Data-----	71
National Weather and Crop Bulletin-----	30
Snow and Ice Bulletin-----	7
Annual Report of Chief of Bureau-----	43

The number of paid subscriptions on our mailing lists at the close of the year was as follows:

	Subscribers.
Washington Weather Map-----	56
National Weather and Crop Bulletin-----	491
Snow and Ice Bulletin-----	49
Climatological Data-----	7

Subscriptions for the Monthly Weather Review are filled by the superintendent of documents from the 75 copies furnished him each month by this division.

Remittances received by the superintendent of documents covering subscriptions for Weather Bureau publications were as follows:

Washington Weather Map-----	\$152. 15
National Weather and Crop Bulletin-----	118. 25
Snow and Ice Bulletin-----	12. 25
Climatological Data-----	48. 30
Station Weather Maps-----	217. 61
Total-----	548. 56

LIBRARY.

During the year 775 books and pamphlets were added to the library, while about 275 were eliminated, by transfer to the Library of Congress or otherwise. The total strength of the collection is now approximately 35,500 volumes. Apart from reference books and files of scientific journals, the books in the library relate almost exclusively to meteorological, climatological, aeronautical, and seismological subjects, including an immense amount of statistical literature, and the collection is quite unique among American libraries. Special efforts were made during the year to bring up arrears of binding. The total of 2,208 volumes sent to the binder was much greater than in any previous year.

AEROLOGICAL INVESTIGATIONS.

The installation of the Drexel Aerological Station was completed, and free observations by means of kites were begun in October, 1915.

Twenty-eight observations to an average height of 2,850 meters were made in October and November, 1915. The addition of a man to the station force in December, 1915, made it possible to begin at that time daily observations in the free air. In addition to the daily observations, when opportunity offered, series of observations continuing for a period of 30 to 36 hours were made. During a series of observations a kite flight is made every three to three and a half hours. The data obtained enable us to follow atmospheric changes in considerable detail. In connection with the daily observations, a daily telegram, giving atmospheric conditions observed at one or two selected levels, is sent to the forecast offices of the Weather Bureau at Washington, D. C., and Chicago, Ill.

In all, 350 observations to an average height of about 2,800 meters have been made up to June 30, 1916. Of these, 88 were made in 11 different diurnal series, 28 were made before December 1, 1915, and the others were made as daily observations.

Owing to the impossibility of importing meteorographs of the kinds we have been using, or of getting parts for them, the work of rebuilding, repairing, and calibrating these instruments has been especially heavy during the past year. In addition to this, a working model of a self-recording balloon theodolite has been constructed and preliminary work done on a simple form of meteorograph and on a manometer for use in calibrating pressure elements of meteorographs directly in millibars. An additional kite reel was built for us by an outside firm, and delivered in November, 1915. Some necessary calibration on the reel has since been completed by us and the machine made ready for issue to a new aerological station.

It has been impossible for the past year or two to import rubber balloons such as we use in making aerial soundings to great heights. We have therefore gone into the subject of the manufacture of these balloons with interested rubber companies in this country, in an effort to have them produced here. A number of sample balloons have been prepared and tested. Some of these have been of fair quality, but not yet suitable for our work.

SEISMOLOGICAL INVESTIGATIONS.

The work of collecting and publishing earthquake data, begun December 1, 1914, has been continued during the past year. These data are of two kinds—noninstrumental reports of earthquakes felt, and instrumental records, often of quakes wholly imperceptible to the senses. The noninstrumental reports are rendered by all the regular stations of the bureau, nearly 200 in number, and also by nearly all the bureau's 4,500 cooperative observers. The instrumental records published by the bureau have been obtained in part by instruments owned and operated by the bureau itself, one at Washington, D. C., and another at Northfield, Vt., and partly through the cooperation of 18 additional stations distributed from Panama to Alaska and from the Hawaiian Islands to Porto Rico.

During the calendar year 1915, 150 earthquakes were felt within the borders of the United States proper. The great majority of these produced no damage whatever, but some three or four were distinctly severe, though only two occurred in populous regions.

SOLAR RADIATION INVESTIGATIONS.

Continuous records of the total radiation received on a horizontal surface from the sun and sky are obtained at Washington, D. C., Madison, Wis., and Lincoln, Nebr., and the daily totals are published month by month in the Monthly Weather Review. For the two first-named stations, which now have records covering periods of 5 years and 6 years, respectively, the daily departures of radiation from the normal, and the accumulated excess or deficiency of radiation for the month and since the first of the year, are also published. During the crop-growing season of 1915 the accumulated departures were quite insignificant at Washington, but showed a marked deficiency at Madison. Between May 1 and August 10 this deficiency amounted to 14 per cent of the normal radiation, and between May 1 and September 30 it amounted to 11 per cent. Between May 1 and August 31 the mean daily temperature over the State of Wisconsin averaged 4.5° F. below the normal, and the development of corn and some other crops was greatly retarded. During the first half of 1916 Madison recorded about the normal amount of radiation, but Washington showed a deficiency of about 7 per cent. There is evidence that this deficiency was even greater in New England and the North Atlantic States, where the development of certain crops was markedly retarded. The exact relation between plant development and the amount of the incoming radiation, and whether the relation is a direct one, or is a secondary effect of the resulting lower temperatures, are questions that can not be answered definitely until the radiation measurements have extended over a longer period of time.

Measurements of the intensity of direct solar radiation on a surface normal to the incident solar rays have been continued at Washington, D. C., Madison, Wis., Santa Fe, N. Mex., and Lincoln, Nebr. At each of these stations except the last named the series of readings extends over a sufficient number of years to give reasonably accurate monthly normals. Between July 1, 1915, and June 30, 1916, the monthly means of the intensities measured were generally above the normal at Madison and Santa Fe, and below the normal at Washington. At the two first-named stations the monthly maxima have generally exceeded those of 1914-15, and are the highest that have been measured since the depression in radiation intensities that followed the eruption of Katmai Volcano in Alaska in June, 1912.

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 15, 1916.

SIR: I have the honor to transmit herewith a report of the operations of the Bureau of Animal Industry for the fiscal year ended June 30, 1916.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

FOOT-AND-MOUTH DISEASE ERADICATED.

The year witnessed the completion of the work of eradicating the infection of foot-and-mouth disease which had persisted since the outbreak was discovered in October, 1914. For more than a year and a half constant warfare had been waged against this highly infectious malady, which at times threatened to break beyond control and ravage our stock-raising and dairy industries as it has those of other parts of the world.

It seemed that the disease had been practically stamped out by the early part of the summer of 1915, but further outbreaks appeared in some localities and the work had to be continued for several months longer. The last herd of cattle affected by the natural spread of the disease, in Christian County, Ill., was disposed of in February, 1916. On May 2, however, reinfection appeared on a previously infected farm among some animals that had been placed there to test the efficacy of the disinfection before the owner was allowed to restock fully. As these premises had been cleaned and disinfected under very unfavorable weather conditions, this last outbreak was not entirely unexpected. The diseased animals were promptly slaughtered and the premises again disinfected, and there has since been no recurrence of the disease there or elsewhere. Sufficient time has now elapsed to make it practically certain that the last vestige of infection has been destroyed, though vigilance has been and still is being exercised to guard against any possible lingering infection and, as far as possible, against the reintroduction of the disease from abroad.

The work of eradication was carried out by cooperation between the United States Department of Agriculture and the authorities of the affected States. The State cooperation was cordial and as a rule

generous and capable, notwithstanding the lack in some States of adequate laws, appropriations, and organizations for such work. The plan followed was in the main the same as in the last two preceding outbreaks of this disease in the United States, with such improvements in details as experience suggested. This method, described in last year's report, consists essentially in quarantine against the movement of live stock and certain materials from infected and suspected territory, inspection to detect diseased animals and centers of infection, tracing shipments of stock and movements of cars from such centers made before quarantines were established, the slaughter and burial or other suitable disposal of diseased and exposed animals, and the cleaning and disinfection of the premises. The animals were appraised before slaughter at their actual meat or dairy value and this amount was paid to the owners, half by the Federal Government and half by the State.

The disease extended to 22 States and the District of Columbia. The affected States are listed in the accompanying table, which also gives statistics of the outbreak and of the work of eradication. Illinois was the chief sufferer, both in losses and duration of quarantine restrictions.

Statistics of foot-and-mouth disease outbreak of 1914-1916.

State.	Counties.		Herds.	Animals slaughtered.					Appraised value of animals.	Duration of outbreak.
	Total. ¹	Infected.		Cattle.	Swine.	Sheep.	Goats.	Total.		
Connecticut.....	8	3	35	701	175	.....	.....	876	\$48,366	Nov., 1914, to Apr., 1915.
Delaware.....	3	1	12	152	49	22	.....	223	8,068	Nov., 1914, to Dec., 1914.
District of Columbia.....	.....	.....	4	48	39	.....	.....	87	7,139	Nov., 1914, to Mar., 1915.
Illinois.....	102	54	1,226	31,074	45,560	1,866	266	78,566	2,569,102	Nov., 1914 to May, 1916.
Indiana.....	92	20	118	2,437	3,973	640	.....	7,050	179,731	Oct., 1914, to Aug., 1915.
Iowa.....	99	9	49	1,547	2,335	32	.....	3,914	125,297	Nov., 1914, to Mar., 1915.
Kansas.....	105	4	12	1,218	313	.....	.....	1,531	76,097	Feb., 1915, to May, 1915.
Kentucky.....	119	11	82	2,942	866	216	1	4,025	135,000	Nov., 1914, to June, 1915.
Maryland.....	24	10	70	1,008	1,784	313	.....	3,105	69,038	Nov., 1914, to May, 1915.
Massachusetts.....	14	9	103	2,066	6,088	78	6	8,238	217,848	Nov., 1914, to Oct., 1915.
Michigan.....	83	16	272	2,951	4,108	818	.....	7,877	212,334	Oct., 1914, to Aug., 1915.
Minnesota.....	86	1	1	25	35	.....	.....	60	2,384	Aug., 1915.
Montana.....	31	3	42	1,416	11	240	.....	1,667	67,603	Nov., 1914, to Jan., 1915.
New Hampshire.....	10	1	3	78	26	.....	.....	104	4,960	Nov., 1914, to Jan., 1915.
New Jersey.....	21	8	52	1,315	815	9	6	2,145	123,387	Nov., 1914, to June, 1915.
New York.....	62	21	219	5,737	625	150	33	6,545	476,578	Nov., 1914, to Aug., 1915.
Ohio.....	88	39	228	4,069	5,003	3,070	.....	12,142	359,971	Nov., 1914, to Apr., 1915.
Pennsylvania.....	67	34	892	15,294	10,634	368	10	26,306	947,958	Nov., 1914, to Apr., 1915.
Rhode Island.....	5	3	59	985	379	33	.....	1,397	71,096	Nov., 1914, to Mar., 1915.
Virginia.....	100	3	9	378	650	.....	.....	1,028	27,744	Nov., 1914, to Mar., 1915.
Washington.....	39	1	1	102	.....	.....	.....	102	4,050	Nov., 1914.
West Virginia.....	55	3	27	194	189	148	.....	531	12,814	Feb., 1915, to Apr., 1915.
Wisconsin.....	71	12	40	1,503	1,435	1,764	1	4,703	119,155	Nov., 1914, to May, 1916.
Total.....	1,284	266	3,556	77,240	85,092	9,767	2123	172,222	5,865,720	Oct., 1914, to May, 1916.

¹ The number of counties in each State is given in order to show, by comparison with the number infected, the approximate area involved.

² Including 9 deer.

In addition to the appraised value of the animals slaughtered there were expenses for disposal of carcasses, disinfection of premises, purchase of supplies, and for travel, subsistence, and salaries of inspectors. The expenditures by the Federal Government amounted in round figures to \$4,600,000. Adding to this a similar sum to represent the expenditures by the States, the total cost of eradication comes to approximately \$9,000,000. Large as this sum is, however, it is

trivial compared with the colossal damage that would have been inflicted if the disease had escaped control and had become permanently established in the United States as it has in some other countries.

The expenses of eradication as paid from the Federal and State treasuries by no means represent the full measure of the cost of this plague. The appraised valuation on a meat and dairy basis in some cases fell short of the actual value of fine pedigreed stock, but the former was all that could be allowed under the then existing law—a condition which has been remedied for the future by a provision in the latest act making appropriations for the Department of Agriculture, under which breeding and pedigree may be taken into account.

The quarantine was gradually removed as areas and States were freed of infection, and the last restrictions were rescinded June 5, 1916. For some time after removal of quarantine veterinary inspectors were kept in the lately infected areas to supervise the restocking of farms where the disease had existed, to see whether the disease developed among animals placed on such farms, and to investigate reports of suspected new outbreaks.

The early history of the epizootic and of the measures taken to combat it is given in the report of the chief of the bureau for the fiscal year 1915. No further light has since been thrown on the source of the outbreak, which appeared in the vicinity of Niles, Mich., late in the summer of 1914. It now seems very unlikely that the true cause will ever be definitely known. The infection undoubtedly came from abroad but in some unknown way.

Out of the misfortune has come experience which should be of great value if the country is ever again visited by this or some other highly infectious animal plague. About 450 veterinary inspectors of the Bureau of Animal Industry, and perhaps nearly as many veterinarians in State work and private practice, took part in suppressing the outbreak and had opportunities for becoming more familiar with the nature of the disease and the best methods of dealing with it. Congress has seen the need of having a fund ready for such an emergency and has recently made a special appropriation of \$1,250,000 to be available for the eradication of foot-and-mouth disease and other contagious diseases of animals in cases of emergency that may threaten the live-stock industry. Some States have adopted laws and appropriated money to the same end. Perhaps the most important step needed to complete our preparation is for all the States that have not already done so to pass laws, create or improve organizations, and make appropriations for dealing effectively with contagious diseases of animals.

PROGRESS AGAINST HOG CHOLERA.

Progress has been made during the year both in practical field demonstrations for the control of hog cholera by serum immunization and in the improvement of the technique of preparing the serum.

The field work has consisted, as before, of (a) county control investigations, being experiments designed to determine the practicability of eradicating hog cholera from selected sections of the country, and (b) demonstrational and educational work with the object of determining the feasibility of enlisting the aid of the far-

mers themselves in efforts to combat the disease. For the first six months of the fiscal year this work was continued under the Biochemic Division. From January 1, 1916, it has been under the direction of Dr. O. B. Hess, leaving to the Biochemic Division the scientific research work. This change was made in accordance with the policy of the department to segregate research, extension, and regulatory work from each other.

In the county-control investigations 1,814 infected herds, comprising 77,141 hogs, were treated, with a loss of 11,905 animals, or 15.4 per cent. There were 26,174 hogs in these herds showing evidence of disease at the time of treatment.

The results following treatment of infected herds with antihog-cholera serum, either alone or in combination with hog-cholera virus, since the beginning of the work, are shown in the following table. From these results it is safe to conclude that, in the case of herds affected with hog cholera, the loss after treatment should not exceed 14 or 15 per cent of the treated hogs, provided the serum alone or the serum and virus is applied promptly after the disease appears. It is well known that without treatment the losses in such herds would average from 80 to 85 per cent. The practical value of this treatment seems therefore to be conclusively established. This table includes only herds infected with hog cholera before the treatment was applied. Experiments have shown that the use of the serum before exposure to infection gives practically absolute protection against the disease.

Results of serum treatment of herds infected with hog cholera, 1913, 1914, and 1915.

Condition of hogs and kind of treatment.	Number treated.	Number died.	Per cent died.
Hogs sick when treated:			
Simultaneous (serum and virus).....	2,448	713	29.1
Serum alone.....	83,099	23,990	28.8
Total.....	85,547	24,703	28.8
Hogs apparently well when treated:			
Simultaneous (serum and virus).....	81,289	3,070	3.7
Serum alone.....	67,300	3,063	4.5
Total.....	148,589	6,133	4.1
Grand total.....	234,136	30,836	13.1

In order to bring out clearly the benefits which have resulted from these county control investigations, the next table is submitted. No official hog-cholera work of any sort was carried on in these counties in 1912. In 1913 work was conducted in only 3 counties, namely, Dallas County, Iowa, Montgomery County, Ind., and Pettis County, Mo. In 1914 and 1915 work was carried on in all of the 14 counties. The table shows that in these counties there was an increase in the number of hogs raised from 859,910 in 1912 to 1,334,644 in 1915, while at the same time there was a decrease in the hogs that died from 152,296 in 1912 to 30,668 in 1915. This means an increase of 474,734 in the total number raised and a decrease of 121,628 in hogs lost. On an average each of these counties raised 33,909 more hogs in 1915 than in 1912, and at the same time lost 8,687 fewer in 1915 than in 1912, thus indicating a net gain per county of 42,596 hogs.

Statistics of hogs raised and hogs that died of hog cholera in 14 experimental counties, 1912 to 1915, inclusive.

County.	Date work begun.	1912			1913			1914			1915		
		Hogs raised.	Number died.	Per cent died.	Hogs raised.	Number died.	Per cent died.	Hogs raised.	Number died.	Per cent died.	Hogs raised.	Number died.	Per cent died.
Decatur, Ga.....	Aug. 25, 1914	48,418	8,546	17.6	52,797	12,225	23.1	55,000	11,618	21.1	80,000	7,595	9.5
Twin Falls, Idaho.....	July 6, 1914	47,673	3,163	6.6	82,563	12,978	15.7	100,000	1,269	1.2	150,000	1,487	1.0
Hendricks, Ind.....	Sept. 3, 1914	63,259	13,532	20.4	72,211	12,908	17.8	85,955	4,065	4.2	107,205	3,075	2.9
Montgomery, Ind.....	July 5, 1913	77,403	24,404	31.5	78,813	5,136	6.4	85,119	2,296	2.6	141,000	5,179	3.7
Clay, Iowa.....	July 10, 1914	73,065	25,000	34.2	87,953	30,268	34.4	89,874	4,209	4.6	92,703	5,578	6.0
Dallas, Iowa.....	July 1, 1913	84,618	19,821	23.4	118,550	12,000	10.1	138,320	6,810	4.9	124,540	1,939	1.6
Marshall, Kans.....	July 6, 1914	65,294	3,853	5.9	72,036	7,930	10.0	65,592	3,432	5.2	101,207	1,561	1.5
Henderson, Ky.....	July 22, 1914	33,814	3,743	11.1	30,866	3,834	12.7	20,000	2,907	14.5	20,000	1,980	9.9
Branch, Mich.....	May 28, 1914	46,170	1,209	2.6	53,338	4,039	7.6	57,878	715	1.2	60,000	210	.4
Renville, Minn.....	May 8, 1914	65,790	8,998	13.6	85,699	43,403	50.4	100,722	5,069	5.0	108,360	347	.3
Pettis, Mo.....	Aug. 1, 1913	59,661	18,853	31.6	107,151	6,386	5.9	136,030	3,847	4.2	149,633	2,906	1.9
Gage and Johnson, Nebr.....	Mar. 31, 1914	76,591	5,445	7.0	80,949	6,012	7.4	71,059	3,541	4.9	78,164	1,744	.9
Davison, S. Dak.....	Oct. 6, 1914	39,920	2,270	5.6	57,695	16,243	28.1	45,430	4,891	10.7	49,000	1,261	2.6
Maury, Tenn.....	July 21, 1914	73,234	8,339	11.4	69,787	6,360	9.1	70,250	3,194	4.5	72,832	3,103	4.2
Total.....		856,910	152,236	17.7	1,052,408	179,125	17.0	1,121,229	59,863	5.3	1,334,644	30,965	2.2

The county-control investigations have served a useful purpose in demonstrating what may be accomplished in that way, and apparently have stimulated activities in a number of the principal hog-raising States. The plan, however, as carried out in an experimental way, with the use of free serum administered by bureau veterinarians, is impracticable and too expensive for extending the work to any great portion of even one State, and has therefore been discontinued.

The educational and demonstrational work was continued in 10 States (Alabama, Arkansas, California, Florida, Georgia, Iowa, North Carolina, Oklahoma, Texas, and Virginia) in collaboration with the States Relations Service of this department and the extension departments of the State agricultural colleges. The activities may be summarized as follows: Fourteen hundred and sixty-six addresses, 402 of which were illustrated with stereopticon views, were made at meetings attended by 138,746 people. Four hundred and sixty-six demonstrations of preventive treatment were made, 335 with the use of serum alone and 124 with simultaneous inoculation, 10,933 hogs being treated, with an attendance of 12,188 persons. Eighteen hundred and seventy visits were made to farms for the purpose of diagnosing hog cholera or observing conditions and giving advice, and 15,812 farmers and hog raisers were personally interviewed. Individual instruction in properly administering the preventive serum treatment was given to 1,336 persons, including 164 county agents, 67 practicing veterinarians, and 1,074 hog owners.

During the coming fiscal year hog-cholera work in the field will be principally regulatory in character, looking to the control of the disease in selected districts, in States where suitable arrangements can be made for cooperation with State authorities charged with the enforcement of quarantine and sanitary measures or with other officials engaged in the control of hog cholera. In States where satisfactory arrangements can not be made for intensive regulatory work some education and demonstrational work will be continued in a modified form. It is believed, however, that the farmers throughout the principal hog-raising districts are already familiar with the possibilities of reducing losses by the preventive serum treatment, and that very little further work of this character should be required.

A new process for producing clear, sterilized antihog-cholera serum has been worked out by Dorset and Henley, of the Biochemic Division. This and other research work relating to hog cholera is reported under the heading of that division.

Sensitized virus, according to the principle first used by Besredka for typhoid fever and by Marie and Remlinger for rabies, has been used in vaccination against hog cholera by Duval and Couret, of Tulane University, who claim to have obtained highly successful results by their process. This method is still in the experimental stage, and the several tests supervised by the Bureau of Animal Industry have not given satisfactory results.

THE TUBERCULOSIS PROBLEM.

A practicable and effective method of eradicating tuberculosis of live stock is greatly to be desired. This is a problem to which the

bureau has given much study. The protection of human health against tuberculosis from animal sources may be reasonably assured by the pasteurization of milk and the inspection of meats. But there remains the economic problem of eliminating the heavy and increasing losses due to the insidious spread of this disease among farm animals.

Cattle and hogs are the most susceptible species and the only ones that need to be considered. There is abundant evidence of the wide prevalence of tuberculosis among these animals. Statistics of tuberculin testing indicate that on an average over 10 per cent of the dairy cattle in the United States are affected with tuberculosis, and in the Federal meat inspection $2\frac{1}{2}$ per cent of the beef cattle and 9 per cent of the hogs inspected during the past fiscal year were found to be so affected. The annual losses directly caused by this disease are estimated at \$25,000,000. In the face of growing demands and higher prices for food products the Nation can not afford to ignore indefinitely such an enormous leakage in its meat and milk supplies.

The most practicable avenues of approach to the problem of tuberculosis eradication seems to be through the pure-bred herds of breeding cattle and the feeding of hogs. This means simply the application of the old principle of purifying the stream at its source. Many herds of fine pedigreed cattle have harbored tuberculosis, and many a stock raiser wishing to improve his stock has instead brought disaster to himself by the introduction of tuberculous pure-bred animals into his herd.

Hogs, because of the early age at which they are slaughtered, do not propagate the disease among their own kind to any appreciable extent, but acquire it from cattle either by drinking infected milk or by following cattle in the feed lot and feeding upon the undigested grain in the droppings. Raw skim milk returned from creameries to patrons and fed to pigs is a prolific source of the disease in swine. The milk from many herds is mixed at the creamery, and if even one lot has the germs of tuberculosis in it the entire quantity may become infected. The remedy for this is simple—merely to pasteurize all the skim milk before allowing it to leave the creamery. This should be required by law.

The elimination of tuberculosis from the pure-bred herds should be accomplished gradually by utilizing the tuberculin test in conjunction with other appropriate measures. In any event the cooperation of the Federal and State Governments and individual breeders will be necessary. One of the first steps should be to spread among the people concerned a knowledge of the facts as to the nature of tuberculosis, how it is spread, and how it may be prevented.

HEMORRHAGIC SEPTICEMIA OR SHIPPING FEVER OF CATTLE.

The disease variously designated as hemorrhagic septicemia, shipping fever, and stockyards fever has been recognized in this country for the past 20 years, but the losses have been unusually large during the past year. Numerous outbreaks occurred during the fall of 1915 and the spring of 1916 in the Central and Northwestern States. The disease has appeared mainly among young cattle in public stock markets or recently shipped through public stockyards, but it has also been found to affect cattle of various ages and some-

times sheep, and in one instance a colt, and has also appeared in localities remote from trading centers.

The bureau has given special attention to the study of this disease and is continuing these investigations. Medicinal treatment is of little value because of the acute and rapidly fatal character of the malady. Resort must be had to preventive measures. Good results have followed preventive treatment with bacterins according to the method of Mohler and Eichhorn of this bureau. Plenty of good water, good feed, and good care during shipping and yarding tend to prevent and reduce the losses. Further details of the work regarding this disease are given in the portion of this report relating to the Pathological Division.

PUBLICATIONS.

Fifty-four new publications, comprising 1,006 printed pages, were issued or contributed by the bureau during the fiscal year. These included 8 Farmers' Bulletins, 7 department bulletins, 7 articles in the Journal of Agriculture Research, 5 articles for the Department Yearbook, 13 issues of Service and Regulatory Announcements, and 13 miscellaneous pamphlets. Numerous articles were also furnished for the Weekly News Letter, and several papers were contributed to outside scientific and technical journals. In addition 60 orders in the nature of regulations were issued. By special resolutions of Congress the books on Diseases of the Horse and Diseases of Cattle were revised and submitted for printing, for distribution by Senators and Representatives.

ANIMAL HUSBANDRY DIVISION.

GEORGE M. ROMMEL, *Chief.*

ANIMAL GENETICS.

The experiments on inbreeding in guinea pigs have been continued. At present there are 17 families in existence which trace back by exclusively brother-sister matings to 17 original pairs. Some of these have reached the sixteenth generation of inbreeding. One family has become extinct since last year. Another was disposed of owing to descent of all living lines from a mating of very doubtful character. The past winter was disastrous to this work. Many matings were lost, and only a very small percentage of the young born were raised. Several families were seriously cut down in size. Most of the stock, however, is recovering rapidly.

The principal new feature of the experiments is extensive cross-breeding between members of different highly inbred families, particularly between families which are in a feeble condition or in which certain opposite characters have become fixed.

Among the controls, important relations have been found with respect to sex ratio, size of litter, interval between litters, gestation period, birth weight and early growth, early death rate, and effects of time of year, of age and condition of mother, and of birth rank. These results are being compared detail for detail with conditions in the different inbred families. The modes of inheritance of certain special traits, such as white and yellow spotting, dilution of color,

polydactylism, absence of eyeball, etc., are also being investigated and have already yielded some very curious facts.

The most obvious result of the work on inbreeding is the mere fact that the closest possible inbreeding for over 10 generations may produce little, if any, degeneration in growth, vitality, or fecundity. As yet no specific effect of inbreeding is wholly certain other than the very important tendency toward homogeneity—the irrevocable fixing of good, bad, or indifferent traits within a family. In the traits thus fixed the first few generations of inbreeding are very important.

This work, with other recent results, suggests that inbreeding may be used more extensively by the practical breeder than it is at present. In the work of producing a new strain, as many different foundation lines of merit as practicable should be started. There should be rigid selection associated with inbreeding in each for a few generations, followed by elimination of inferior lines. The result should be a few lines practically as vigorous and fecund as normally bred stock, yet showing a uniformity of type unattainable without inbreeding.

ANIMAL HUSBANDRY EXPERIMENTAL FARM.

At the experimental farm near Beltsville, Md., considerable progress has been made in drainage, and the effects indicate that the land has been improved by this process. It is expected to continue the draining as funds permit until all the tillable portion of the farm is thoroughly drained. During the year some clearing of land has been done. A small abattoir has been erected for use in following the feeding investigations to definite conclusion and noting the effects of feeds on carcasses produced.

BEEF-CATTLE INVESTIGATIONS.

The beef-cattle investigations, started in 1904 in cooperation with the Alabama experiment station, were begun in the firm conviction that the South presented opportunities for the extension of the beef-cattle industry which had been overlooked, and that the circumstances which were tending to curtail production in other sections of the country would compel beef production in southern territory. Although there was comparatively little demand at the time for information on beef production in the South, it was felt that this demand would in time become apparent. Investigations were therefore begun with the idea that by the time definite information on the subject was needed the department would be in a position to furnish it. The southern territory is now regarded by everyone familiar with the beef-cattle industry as a fruitful field for future development. Breeding herds are being established throughout the South, and the leading beef-cattle breeders' associations are featuring the southern trade; two of them hold sales in cooperation with this department. Cattle from southern herds have won the highest honors in northern show rings, and steers from southern feed lots, after having been properly fattened, now command high prices in northern markets.

Until recently practically all of our beef-cattle work was done in southern territory, south of the Ohio River and east of the Missis-

issippi. The field has now broadened and work is being carried on also in other sections of the country.

BEEF PRODUCTION.

Except for the first three years, the experimental beef-cattle work has been conducted on the farms of owners of herds of beef cattle. The owner of the farm furnishes all the cattle, feed, equipment, etc., the department stationing a trained man on the farm to take charge of the herd and keep the records. The results obtained on these farms are therefore applicable to any other farm in the same section and under similar soil and climatic conditions. This arrangement has made possible the prosecution of this work at a very low cost, and the method followed has given farmers great confidence in the results obtained.

Growing beef animals.—An elaborate study of growing beef animals, in cooperation with the Office of Farm Management, was conducted on farms in the corn belt. The results were published in Report No. 111, being Part III of the report on the "Meat Situation in the United States." This is the most comprehensive and complete report that has ever been made on the subject. Records were obtained on the cost of raising calves from over 14,000 cows of the corn belt. The report shows that the cost of producing calves is higher than is usually thought, but that when all things are considered the calves can usually be raised at a profit. This work is to be continued.

Two herds of breeding cows are maintained in Mississippi and one herd in West Virginia, in cooperation with the State experiment stations, to study the cost of producing beef calves in those sections.

Fattening cattle.—At Canton, Miss., in the brown-loam section of the State, four car lots of steers were used in winter feeding in making a comparison of roughages for fattening steers. The four lots received an average daily ration of 7 pounds of cottonseed meal per head. The first three lots were used to determine whether it was more profitable to feed corn silage as the sole roughage in the ration, or to combine silage with a small quantity of corn stover or oat straw. The three car lots of silage-fed steers gained slightly over 2 pounds per head per day for the entire period of 126 days. They sold for \$8.45 per hundred pounds on the St. Louis market; dressed out 58.2 per cent. and made an average profit of over \$10 a head. The steers of the fourth lot, which were fed on dry roughage, made a profit of \$6.51 a head.

Three car lots of steers were used in the winter feeding work at Abbott, Miss., in the black-prairie section. All the steers received the same roughage, 36 pounds of corn silage and 4 pounds of straw per head per day. A comparison was made of the relative efficiency of cottonseed meal alone as compared with a combination of cottonseed meal and corn for fattening the steers. The steers receiving corn made larger gains per day. With corn charged at 70 cents a bushel, the increased gain in weight was not quite large enough to overbalance the increased cost of the feeding. If corn had been charged at 63 cents a bushel the profits on all lots would have been the same.

Three lots of beef calves were fed out as baby beef on the same farm, and a similar comparison made as between cottonseed meal and

combinations of cottonseed meal and corn. All received 4 pounds of alfalfa hay per head per day with all the silage they would eat. With corn at 70 cents a bushel, it was more economical to feed the calves on cottonseed meal alone. If corn had been charged at 50 cents a bushel the calves receiving corn would have made considerably larger profits than those receiving cottonseed meal as the sole concentrate. If steers and calves which are fed corn are followed by pigs to consume the waste, the results indicate that feeding baby beeves on corn may be profitable in Mississippi.

Maintenance of stockers and feeders.—The experimental work in wintering cattle was continued in North Carolina and West Virginia in cooperation with the State stations. The work in North Carolina was a duplication of the work of the previous year in studying economical methods of wintering beef steers. The results of the 1916 work were almost identical with those of the two preceding years. The common practice of wintering steers on ear corn and corn stover, hay, and straw was the most expensive method used in either North Carolina or West Virginia. Steers fed a medium ration of corn silage and dry roughage wintered equally as well as those which received ear corn and dry roughage, and were wintered at \$5 a head less expense. The practice of winter-grazing steers on mountain lands which have been permitted to grow up in meadows during the summer proved very satisfactory. The cost of wintering steers in this manner in North Carolina was \$5.30 per head, as compared with \$12.14 per head where they were fed on dry roughage and ear corn. The steers which were winter-grazed made a gain of 26 pounds per head during the winter, whereas the steers fed ear corn lost 34 pounds per head during the same period. The experimental work with both yearling steers and beef cows in West Virginia indicates clearly the advisability of using corn silage and cottonseed meal for wintering the animals in preference to using dry roughages.

BREEDING SHORTHORN CATTLE.

Experiments in breeding Shorthorn cattle, designed to study a problem in Shorthorn breeding which has puzzled breeders and other students for some time, were begun during the year, in cooperation with the Kansas experiment station. The Shorthorn cows which have been producing the show winners in this country are not of the type which themselves would win in the show ring. The Kansas Agricultural College has had a creditable record in the exhibition of show steers, especially Shorthorns. These Shorthorn steers have never come from cows of show type. The object of the experiments is to determine whether beefiness is a characteristic of sex, and in what way it is related to functional development; also whether it is possible to produce a herd of animals that will have a double standard—one for males and another for females—rather than a dual-purpose type, which is a compromise between the two ideals; in other words, whether it is possible to produce a herd of cows that will be good milkers and will transmit the milking function to their heifers and at the same time transmit the tendency to beefiness in the males and also in females previous to calving.

For the experiments a herd of 20 Scotch and Scotch-topped Shorthorn cows has been selected. Each of these cows has produced one or

more outstanding beef calves. The Shorthorn herd bull of the Kansas Station, Matchless Dale, 291609, is being used to head the herd. This bull is an individual of exceptional scale and quality, and is the sire of more show steers than any other living bull. The first crop of his calves out of the cows in the experiment will arrive during the coming fall and winter.

Shorthorn breeders are very much interested in the outcome of this investigation. Tentative studies seem to indicate that the conditions outlined above are not peculiarly problems confronting Shorthorn breeders, but probably apply in other breeds of beef cattle. There is, however, a further and wider application of this problem. If the theory is correct that a good beef animal must have a good milking mother it will have a profound effect on the range practice of eliminating the thin cows.

BEEF-CATTLE EXTENSION WORK.

The beef-cattle work in the Panhandle of Texas was continued. The object is to promote the growing of forage crops and the fattening of beef cattle for market, instead of producing "feeder" cattle exclusively as heretofore. The regular work was conducted in 20 counties and preliminary work was done in about the same number of other counties. There was not as much feeding in the Panhandle during the past winter as during the winter of 1914-15, but the work was far more satisfactory, financially and otherwise. Good profits were made by most of the feeders, and the nonsaccharine sorghums are proving very satisfactory for cattle feeding.

The first cattle sale held by the Panhandle Hereford Breeders' Association proved a success. Our agent there has aided the breeders materially in disposing of their surplus breeding animals.

LIVE-STOCK DEMONSTRATION.

The live-stock demonstration work carried out under the provisions of the tick-eradication appropriation is almost entirely devoted to the promotion of the beef-cattle industry. Under the limitations of the appropriation it is conducted only in areas which have been freed of ticks. This work is carried on in North Carolina, South Carolina, Georgia, Tennessee, Arkansas, Alabama, and Mississippi, the two last-named States having been added during the year. It is done in cooperation with the Field Inspection Division of the bureau, the States Relations Service of the department, and the State agricultural colleges.

During the past fiscal year the agents were directly responsible for the introduction of 862 head of registered beef cattle, about 40 per cent of which were bulls, and they assisted indirectly in the purchase of many more. They visited and gave specific information to 3,552 farmers on beef-cattle problems, attended and addressed 584 meetings with a total attendance of about 62,454 persons, assisted in getting 217 beef-cattle farmers to build silos, and conducted 181 feeding demonstrations with a total of 11,284 cattle. One or more field meetings were held on the farms on which the demonstrations were conducted and the results were explained to those present. This has proved to be one of the most popular and forceful methods of pre-

senting information to the farmers. Methods of feeding are explained, and the animals are on hand to show the results that were obtained.

One hundred and eighteen demonstrations on the roping, castration, and dehorning of cattle and on the improvement of pastures were conducted before 3,348 farmers. After a few animals were operated on, the farmers were asked to try the operation. This induces many farmers to dehorn and castrate their calves at the proper time and forwards the campaign against the scrub bull.

Twenty additional live-stock organizations have been formed with a membership of 925. Assistance is given the officers of these associations to keep them active and increase their efficiency.

In addition to the cattle which were fed in the demonstrations, the agents supervised in a general way the feeding of many more. In South Carolina about 1,500 head were fed in the demonstrations, but about 4,100 were fed according to directions furnished by the agents. Three cooperative sales were held at the end of the feeding period, which were attended by buyers from New York, Baltimore, Richmond, and several small cities of the East. The cattle brought very satisfactory prices. The difference in the selling price of poorly finished scrub cattle and well-fattened, high-grade cattle was forcefully illustrated to the hundreds of people present, some of the scrubs bringing 4 or 4½ cents a pound and one lot of high grades selling for 9 cents a pound.

In Tennessee the agents have assisted in introducing pure-bred bulls. In Alabama a number of feeding demonstrations were conducted, showing the comparative value of some of the common feed-stuffs for fattening cattle.

In Mississippi the agent devoted part of his time to the organization of baby beef clubs. On June 1, 1916, there were 571 members, and they are preparing to have an exhibit of calves at the State fair in the fall. The agent has also organized stock-judging teams at 11 schools, to take part in a stock-judging contest at the State fair. Several hundred boys are receiving the benefit of this training in live-stock judging.

SHEEP AND GOAT INVESTIGATIONS.

RANGE SHEEP INVESTIGATIONS.

The experimental flock of sheep at Laramie, Wyo., numbers 900 ewes, including 180 yearlings to be bred in October, 1916. The 1916 lambing yielded 340 Rambouillet, 54 pure Corriedales, and 200 by Corriedale sires from dams of four different long-wool crosses.

Although the owners of the ranch upon which this flock has been kept have furnished good facilities for the work and have given all possible assistance, the labor required and the numerous divisions which the experiments demand have passed beyond what can reasonably be expected upon a ranch not wholly devoted to investigational work. During the year a suitable area of land in Fremont County, Idaho, was withdrawn from entry by Executive order, to be used as a United States sheep experiment station. Negotiations with the Forest Service are in progress to procure suitable and convenient summer grazing. It is expected to transfer the flock in Wyoming to the new ranch during the coming fiscal year.

The 65 Corriedale ewes imported from New Zealand were placed in the range band in May, 1915. Careful observation shows that these sheep stay in the band closely enough for the real needs of modern range management. They are less inclined to roam than are the most first cross-bred ewes; in fact, so far as herding is concerned there is no distinction between the bureau's Corriedales and the Rambouillets that chiefly make up the remainder of the band. This was one of the important questions concerning the breed that could not be answered before importation, and the favorable answer is of considerable value to the range-sheep industry.

There have been no losses among the Corriedales. They remained with the band upon the winter range without any artificial feeding until March. In that month they were brought to sheds for lambing and proved to be thinner than is desirable for that time. As only dry feed was then available, a "break" in the wool resulted that lowered its value when shorn. Of 64 ewes bred, 61 produced lambs, including 18 pairs of twins. Owing to the low condition of the ewes a number of lambs were very weak at birth and only 54 were raised.

The average weight of fleece of the Corriedales when shorn the last of June was 10 pounds. A shrinkage test of the wool showed a loss in scouring of 57 per cent, which is considerably below the average for the best cross-bred ewes on the range. In length, quality, and character the fleeces were fully equal to those of ewes of the breed grown in New Zealand.

The 1915 crop of Rambouillet lambs showed a marked advance toward the type that has been held continuously in view since the project of producing a range type of sheep was started. The records of the flock show that there is a much better prospect of increasing the length of wool and obtaining better character when extreme fineness is not insisted on. In many cases this more robust type of wool comes from the better bodied animals. It therefore appears that the flock now contains most of the material needed in the further evolution of the type sought, and that in the future progress may be made at a more rapid rate.

FARM SHEEP INVESTIGATIONS.

At the Beltsville, Md., farm the projects of the production of Persian lamb fur and the production of an early lambing type of mutton sheep have been discontinued since the loss of the stock in the fire of last year.

In the fall of 1915 the Southdown yearling ewes and the ewe lambs from the flock at Middlebury, Vt., were transferred to the Beltsville farm. Thirty acres have been prepared for use exclusively for sheep. The object is to determine the maximum number of ewes that can be maintained under Central Atlantic State conditions with practical methods of management. The flock will also be used in experiments to obtain data upon factors controlling the yield of lambs and the rate of growth and maturity in lambs.

Fifty Southdown ewes of breeding age have been retained in the flock at the Morgan Horse Farm at Middlebury, Vt. These are being used to show the best methods of practical farm flock management in New England, paralleling the work at Beltsville. There is a marked revival of interest in sheep raising in New England, and

the surplus rams from our flock are being more eagerly sought for each year. The number of lambs raised in 1916 was 125 per cent of the number of ewes bred, and their average weight on July 1 was 65 pounds. They were valued by local shippers at 10½ cents a pound live weight at the farm. No feed or methods were used that would not be practicable for farmers' commercial flocks. Had the lambs been marketed instead of held for breeding, the average income from lambs and wool would have been \$10 per ewe.

MILCH GOAT INVESTIGATIONS.

The number of goats milked at the Beltsville farm has been reduced to 15 by transfer of part of the stock to the Sea View Hospital, Department of Health, New York City. A cooperative plan has been made with that institution whereby the value of goat's milk for feeding tuberculous patients and infants will be thoroughly tested and the results of the experiments furnished to this bureau. Arrangements have also been made with the New York Foundling Hospital to conduct cooperative studies of the value of goat's milk for infants.

Tests of milk-producing rations are being made with the does now being milked at the Beltsville farm. The kids are being fed upon different milk substitutes to decide upon a practicable feed that can be recommended to goat owners who must use all the milk for their families and who still desire to raise the young stock.

PREPARATION OF WOOLS.

Important progress has been made in the campaign in Western States for improvement in the preparation of wools for market. It has always been apparent that the main need was for a greater familiarity with market requirements on the part of the wool growers. An educational exhibit of wools, showing grades and values as well as common defects preventable by range management, was prepared. Live sheep as well as fleeces were used. The car containing this exhibit was circulated in Montana, Idaho, Wyoming, and Utah under cooperative arrangements with the agricultural colleges of those States. More than 50 towns were visited, chiefly in Wyoming and Utah. A continuation and extension of this work is proposed as soon as further arrangements can be made with the colleges. A motion picture film showing the processes of worsted manufacture as well as warehouse grading has been prepared for use in this work during the year.

SWINE INVESTIGATIONS.

PORK PRODUCTION.

Pork production investigations at the Beltsville farm have been held back somewhat, waiting for the equipment of the abattoir. Experiments are in progress to determine the relative value of certain forage crops for growing pigs. In cooperation with the bureaus of Chemistry and Plant Industry, studies have been made of the value of dried, pressed potato, supplemented by feeds rich in protein, for fattening hogs. Experiments have also been made to determine the value of potato silage as a feed for swine, and this work is being

continued. In view of the great use which is made of potatoes in European countries, it appears that there is an opportunity in the United States to utilize waste potatoes by feeding them to pigs, and at the same time to increase the production of pork.

The studies on the effects of cottonseed meal when fed to hogs are being continued.

PIG CLUBS.

On June 30, 1916, there were over 21,000 members in the pig clubs directed by the agents of this division. This is almost double the number recorded January 1, 1916. The work of the pig clubs is described in an article by Mr. W. F. Ward in the Department Year-book for 1915.

HORSE AND MULE INVESTIGATIONS.

BREEDING AMERICAN CARRIAGE HORSES.

Progress has attended the horse-breeding experiments, being conducted in cooperation with the Colorado experiment station, where a type of horse suitable for carriage use and general purposes is being produced. Good results are noticed where inbreeding with carefully selected individuals is being followed. Sixteen live foals constitute the 1916 colt crop, the four best foals of which are the result of mating the stallions Albion and Carnagie to half sisters. The stallions Carmon, Wilmering, Albion, and Carnagie are being used in the experiment, and are also being bred to outside mares. Sixty per cent of the mares used in the experiment which were bred in 1915 proved to be in foal. The stallions Defender and Highball have been standing for public service at Carbondale and Montrose, Colo., respectively, and were well patronized.

As recommended by the board of survey, 18 animals were condemned as unsuitable to be retained for breeding purposes. The mares Indiana and Belladonna and a weanling foal died during the year.

The following table shows the number of animals of various ages in the stud on June 30, 1916:

Horses in Colorado stud, June 30, 1916.

Age.	Stallions.	Mares.	Geldings.	Total.
5 years old and over.....	5	23		28
4 years old.....		4		4
3 years old.....	3	4		7
2 years old.....	2	10	2	14
Yearlings.....	7	8		15
Weanlings.....	8	8		16
Total.....	25	57	2	84

Close observations are still being made on the effect of feeding brood mares on alfalfa hay during the winter and pasturing them on alfalfa during the summer. No ill effects have as yet been noticed where this system of feeding is carried on judiciously.

BREEDING MORGAN HORSES.

On June 30, 1916, there were in use at the Morgan Horse Farm near Middlebury, Vt., 15 mature stallions, 11 young stallions, and 41 mares, of which 20 are mature. Twenty-one mares were bred in 1915, and 18 of these are either heavy in foal or have dropped colts. On May 1, 1916, one stallion and one gelding were disposed of. Two stallions from the farm were sent to North Carolina for public service. The Morgan stallion Scotland has recently been added to the farm's breeding stock. The stallions in service at the Morgan Horse Farm, besides being mated with the pure-bred Morgan mares belonging to the department, are also bred to outside mares on the army remount plan.

The farm is now almost fully equipped. Some fencing remains to be done, and here and there extensions to the tile drainage system are needed. An experimental planting of alfalfa promises well, and a larger planting is contemplated in 1917.

BREEDING HORSES ON INDIAN RESERVATIONS.

The work in breeding horses on Indian reservations is progressing satisfactorily. Eight stallions are maintained under this project, with headquarters at Eagle Butte, S. Dak. Four of the stallions are Percherons, two are Standardbreds, and two are Saddlebreds. The mares are bred in corrals which are adjacent to large pastures. All the mares bred are owned by Indians, but they change hands frequently, and some are sold to white men. For this reason it is somewhat difficult to have an exact count of all the foals produced by these mares. During the calendar year 1915 approximately 240 foals were dropped. Four hundred and twenty-six mares were bred in 1915 and approximately 275 foals were dropped between January 1 and June 30. Three hundred and twelve mares were bred during the first six months of the calendar year 1916. Most of the mares are bred in July, some breeding being done through August and September. An instance of the success of this work is the case of an Indian who bred 36 mares in 1915. These mares dropped 31 living foals the following spring. This year this man turned in 108 head to breed, most of which are being bred to the light stallions. The foals produced by the Government-owned stallions are decidedly superior to those sired by range-bred stallions.

BREEDING HORSES FOR MILITARY PURPOSES.

As a result of the experimental breeding work done in 1912 in cooperation with the War Department at Front Royal, Va., and at Middlebury, Vt., to determine the practicability of the plan of the Agriculture and War Departments to encourage the production of horses suitable for military purposes, colts sired by the Thoroughbred stallions Henry of Navarre, Octagon, Footprint, and Belfry II, the Morgan stallions, General Gates and Bennington, and the Saddle stallion, Marshall King, were eligible for purchase this year; and out of the 28 colts inspected to June 30, 1916, by officers of the Quartermaster's Department of the Army, 26 were accepted and are now at remount stations.

The plan under which this work is carried on was definitely put into effect in 1913, under Congressional authority, on the following terms: The owners of suitable mares may breed them to Government remount stallions free of charge by giving the Government an option at \$150 on the resulting foals during the year they are 3 years old. In case the foal dies, gets hurt, or is not taken by the Government no service fee is charged. If the owner wishes to relieve himself from the option he can do so at any time by paying a service fee of \$25.

In the first breeding district, which includes Vermont and New Hampshire, with headquarters at Middlebury, Vt., stallions of the Morgan breed are used. In the second district, composed of Virginia and West Virginia, with headquarters at Front Royal, Va., Thoroughbred, Standardbred, and American Saddle stallions are in use. The third district comprises Kentucky and Tennessee, with headquarters at Lexington, Ky. In this district Standardbred and American Saddle stallions are used. No stallions are retained in service unless they remain sound and are sure foal getters. A very large percentage of the foals produced give promise of being useful either as general utility farm horses or as Cavalry and Artillery horses. Beginning with 1914, foals bred on the remount plan have been shown successfully at various fairs and horse shows, both in classes exclusively for them and in classes open to all entries.

The following table shows the results obtained from the stallions in service in the respective districts, beginning with the season of 1913:

Record of stallions in Army horse-breeding work.

District.	Breed- ing season.	Number of stal- lions used.	Mares bred.	Living foals.	Aborted or dead foals.	Number of mares not getting in foal.
First.....	1913	7	280	105	18	157
	1914	9	299	126	21	152
	1915	7	301	¹ 87	¹ 26	¹ 127
	1916	5	¹ 103			
Second.....	1913	22	848	319	50	479
	1914	23	966	406	47	513
	1915	18	989	¹ 397	¹ 20	¹ 326
	1916	19	¹ 986			
Third.....	1913	12	423	182	43	198
	1914	11	749	286	41	422
	1915	12	883	¹ 370	¹ 49	¹ 368
	1916	12	¹ 816			

¹ Includes only reports received to June 30, 1916.

Many applications for remount stallions for particular districts can not be filled because the funds available do not permit of extending the work. With Government aid in furnishing suitable sires, farmers are glad to cooperate in producing horses which will give the country a reserve that may be drawn upon for military use in case of hostilities, and during peace insure useful Cavalry and Artillery horses and general utility farm horses. The quality of the horse stock is gradually being improved where remount stallions stand.

POULTRY INVESTIGATIONS.

POULTRY BREEDING.

In the poultry breeding experiments at Beltsville hens of the following varieties are being trap-nested so as to keep records of pedigrees and of individual egg production: White Leghorns, Buff Leghorns, White Plymouth Rocks, Barred Plymouth Rocks, Rhode Island Reds, White Wyandottes, cross-bred hens, and mongrel farm hens. Of these a few hens are being trapped for their third year, a considerably larger number for their second year, and over 300 for their first year. During the spring about 70 matings were made, with the idea not only of carrying on the lines of breeding already started but also of trying new combinations for the purpose of increasing egg production and fixing, if possible, high fecundity in certain strains. These efforts have been mainly along the lines of concentration of the blood of some of the better producing lines and individuals, selection on the basis of performance only, and selection based on early production. In addition studies are being made of the effects of mating birds of poor production. In connection with breeding for egg production, the compilation of data regarding the behavior of certain characters in inheritance and of certain factors associated with egg production is being continued.

A line of work has been undertaken in which typical farm mongrel pullets are being mated to pure-bred White and Barred Plymouth Rock males for the purpose of seeing what can be accomplished in the way of grading up the mongrel flock to greater uniformity in both appearance and product. The effect upon egg production of this system of grading up is also being studied.

About 1,000 chickens from the various matings are being reared with which to continue the lines of breeding already undertaken. Weekly weights of some of the growing chickens of the different breeds are being kept for the purpose of comparing the rate of growth and of establishing some basis as to what constitutes normal growth.

Decided progress has been made during the year in the cross-breeding work. Quite a number of chickens have been obtained showing good white plumage, yellow legs, four toes, and solid red ear lobes. Some of these individuals approach closely to the type desired.

COMMUNITY BREEDING OF POULTRY.

The community poultry-breeding efforts which were started last year have met with much favor. In 1915 this work was carried on in only one State (Virginia) at three points, with approximately 100 members. At the close of the fiscal year community poultry-breeding centers existed in three States (Virginia, Kentucky, and Tennessee) at 18 points, with 389 members. The general idea is for the poultry-club members of a community to select and keep only one breed or variety of chickens, for the purpose of making the poultry products of that locality more uniform in character, strengthening the common interests of the poultry keepers, and enhancing the reputation of the community as a poultry center. In most cases the Barred

Plymouth Rock has been the breed selected, but White Leghorns, White Plymouth Rocks, White Wyandottes, and Rhode Island Reds also have been used.

POULTRY FEEDING.

All the pens of fowls in the feeding tests have been continued for another year, making the fourth consecutive year for the six original pens. These experiments now include 20 pens with a total of 500 fowls. Rations which have given good results in previous tests are being tried under different conditions and with different breeds. The pens that were started on fish meal and on cottonseed meal have been continued, and new experiments have been begun to compare mussel meal with beef scrap. The fish meal is proving a good substitute for beef scrap and is an economical feed, while continued poor results are being obtained from the cottonseed meal. Eggs from the cottonseed meal ration are both expensive and of poor quality, the latter condition being especially noticeable during warm weather. So far the mussel meal is not giving nearly as good results as beef scrap. A pen of Leghorns was started on a ration which does not contain wheat or any wheat products. The egg production has been excellent in this pen, and the cost economical.

Three pens of mongrel fowls have been added to the feeding experiments to be used jointly in this and in the breeding work. Beginning this year, trap-nest records are being kept of all new feeding pens.

The highest yearly average pen production to date is 169.5 eggs per hen. The Leghorns greatly outlay the general-purpose breeds in their third year, the three-year average production for the Leghorns being 122 eggs, against 102 in the best general-purpose pen. The value of eggs from the general-purpose breeds in their third year does not greatly exceed the cost of feed, while the Leghorns show a profit of \$1.94 per head above the cost of feed, no other costs being included.

IMPROVEMENT OF MARKET EGGS.

The campaign for the improvement of the farm egg has been continued by advocating the production of infertile eggs. The department has mailed to interested persons to be posted in prominent places about 50,000 of the egg placards which graphically show the difference in the keeping qualities of fertile and infertile eggs. "Rooster day" campaigns for the marketing of male birds have been conducted in several States. In distributing these placards the department has had the cooperation of the Post Office Department in having them displayed in post offices. The placard is also posted in many banks in States where the work has been prosecuted.

TURKEY AND GUINEA-FOWL INVESTIGATIONS.

The study of turkey and guinea-fowl conditions made in connection with feeding, breeding, and incubation, both by natural and artificial means, which was conducted in a large turkey-producing section of Texas last spring, where much valuable information was obtained, is being continued in a similar manner in northern New York. A proposed Farmers' Bulletin on turkey raising, embodying the latest

information on the subject and based largely on the observations of the division's representative in the field on farms where turkeys are successfully raised, has been prepared.

PIGEON AND SQUAB INVESTIGATIONS.

One end of the new breeding house at Beltsville has been fitted up for pigeons, and about 15 pairs of popular breeds of pigeons used for squab production have been purchased. These breeds include the German Runts, Carneaux, French Larks, Homers, White Kings, and Hen pigeons. Several pairs of offspring have been obtained and are being reared for breeding purposes. Records are being kept of the production from each pair, also of the weights of the squabs at hatching and at the end of each week until they leave the nest. A ration composed of equal parts by weight of wheat, cracked corn, kafir corn, and Canada peas is being fed, and records are being kept of the amount of feed consumed.

OSTRICH INVESTIGATIONS.

The ostrich work which is conducted on a ranch at Glendale, Ariz., in cooperation with the Arizona Ostrich Breeders' Association, has made favorable progress. Studies in the feeding and breeding of ostriches for the purpose of increasing the production of high-quality feathers have been made. Among the young chicks raised are several from the cross of the Nubian and South African birds. It is believed that by such a cross an improvement in the quality of the feathers may be accomplished. Feeding experiments are also being made with these chicks, and the work in artificial incubation and brooding is being continued.

POULTRY CLUBS.

The work of forming and conducting poultry clubs for boys and girls in cooperation with the States Relations Service of the department and State agricultural colleges has been continued. Oklahoma has been added to the list of States in which this work is being carried on, making in all seven States, the others being Virginia, North Carolina, South Carolina, Kentucky, Tennessee, and Georgia. Clubs have been organized in 216 counties in these States, as compared with 95 counties for the preceding year. The membership now numbers 8,506, an increase of 4,769 over the year before.

In the fall of 1915, 994 of the members exhibited 3,322 fowls and 151 dozen eggs at 40 different exhibitions. The cash and special prize awards which these members earned as the result of exhibiting their products amounted to \$1,476.74. Some of the members were able to win with their fowls in open competition with the exhibits of experienced poultrymen. Great interest is being shown in poultry club work, both on the part of the club members and on the part of parents and other persons in the localities in which the clubs exist. Many of the children are able to earn considerable sums of money as a result of their poultry work, and many of them express the intention of using this money in further education, particularly in agricultural education.

Further details of the poultry club work will be found in an article by Rob R. Slocum in the Department Yearbook for 1915.

CERTIFICATION OF PEDIGREES.

Under the provisions of paragraph 397 of the tariff act of October 3, 1913, the bureau issued during the fiscal year certificates of pure breeding for 462 horses, 565 dogs, and 5 cats imported for breeding purposes.

DAIRY DIVISION.

B. H. RAWL, *Chief.*

Significant new features in the work of the Dairy Division are the growth and interest in the manufacture of cheese in the southern mountain sections, in the irrigated regions of the West, and on the Pacific coast; the beginning of community development in dairying in the South; the boys' and girls' dairy work in the schools; and the excellent results obtained in the disposal of creamery and cheese-factory by-products.

Activities of some kind were carried on in 43 States. Most of the work is of a cooperative nature, the usual cooperative agency on the part of the State being the extension division of the college of agriculture. The cooperation also includes the States Relations Service of the department, dairymen's and breeders' associations, etc.

In the course of these activities 2,462 public meetings of various kinds were attended by representatives of the Dairy Division. These meetings included fairs, exhibitions, conventions, farmers' institutes, short courses in dairy instruction, lectures, demonstrations, scientific gatherings, local meetings, etc. Advice and assistance were given in constructing 517 silos, 155 barns, and 148 milk houses; in remodeling 112 barns and 16 milk houses; in the purchase of 1,795 head of cattle, of which 262 were pure-bred bulls and 389 pure-bred heifers and cows; in organizing 104 cow-testing associations, 8 bull associations, 19 breeders' associations, and 12 miscellaneous dairy associations; in keeping the records in 420 herds, containing 6,386 cows; to 66 cities in improving their milk supplies; in 14 milk contests; to 112 schools; to 145 creameries and 35 cheese factories in improving their products and methods of manufacture; in organizing 14 creameries and 19 cheese factories; and in the organization of 21 cream routes.

DAIRY FARMING INVESTIGATIONS.

The work of the Dairy Division relating to dairy farming is in charge of Helmer Rabild.

SOUTHERN DAIRYING.

The interest in dairying and in the development of the industry in the South have been very marked. New features of the year have been the formation of cow-testing and bull associations, while the improvement and development of work already begun has been of a very fundamental character and more important than the introduction of new lines. The encouragement of the building of silos, an old and important line of work, is being rapidly shifted to the de-

partment's county agents, since they can work with individuals more extensively than is now practicable for the Dairy Division.

During the year the field men assisted in organizing 21 associations, including 3 bull associations, 3 cow-testing associations, and other live-stock associations; they introduced records in 89 herds, attended 604 meetings and 12 fairs, assisted in building 193 silos, 112 barns, and 108 dairy houses, and assisted in the purchase of 927 cattle, including 166 bulls, and in the establishment of 2 college creameries. Eleven pure-bred bulls were placed within a radius of 5 miles in the cotton-boll-weevil district of Mississippi. Some of this work was done under a special appropriation for the development of dairying in areas that have been freed of cattle ticks. Ten men are engaged especially in the latter work.

A conference of the field men working in the South was held at Birmingham, Ala., June 6 to 8, 1916. The extension problems of the southern field were considered and much good was accomplished in the exchange of ideas and in promoting uniformity of work.

COW-TESTING ASSOCIATIONS.

In the Eastern and Middle Western States the development in dairying is so well advanced that work with individuals is impracticable. Efforts are therefore concentrated upon the development and supervision of organizations which will benefit communities. Working with and through the county agents it has been possible to cover a larger territory and at the same time add to the effectiveness of the work. The county agent furnishes the local supervision which is so necessary in maintaining organizations at their maximum efficiency. The hearty cooperation of the State extension and dairy departments has proved very valuable.

Cow-testing associations were formed in States where there were none before and many new associations were organized in the old States. In all 135 new associations were organized during the year and the total number now comprises 346 associations with 8,886 members and 150,677 cows.

This work protects the dairyman against losses due to haphazard methods, stimulates cooperation, introduces business system, and places dairying on a more highly remunerative basis. Evidence of these facts is found everywhere in the sections where such associations have been organized and the cow-testing association is rapidly becoming an essential part of the rural organization in dairy districts.

Cow-testing exhibits were held at the Ohio, Minnesota, and Nebraska State fairs and at the Iowa Dairy Cattle Congress. All these attracted much attention and concretely demonstrated the value of record keeping. As a result of the Iowa exhibit three new associations are now in operation in communities which received their inspiration from it.

In connection with the cow-testing work the field men have helped dairymen with barns, silos, feeding, purchasing cattle, and general dairy management. Associations have been encouraged to buy feed, market the surplus stock, advertise cooperatively, and become better acquainted with their neighbors' herds and methods. All this tends to place dairying in the community on a more stable and profitable

basis. When cow-testing associations could not be organized, farmers were urged to keep their own records.

BULL ASSOCIATIONS.

One field man was assigned to the promotion of bull associations, the object of these organizations being to furnish pure-bred bull service at small cost through cooperative ownership. A survey of the field showed that about 50 associations had been organized during the last nine years, of which about 25 had discontinued operations. The causes of failure were found to be chiefly poor business management and the lack of local leadership. As a result of a study of both active and discontinued associations plans were formulated for embodying their good and eliminating their undesirable features. Organizations were then effected in Iowa, South Carolina, North Carolina, and Massachusetts. In these associations, in sections representative of varied conditions, new plans are being tried out under careful observation before any large movement for pushing bull associations is undertaken.

At present there are 32 active associations in 15 States, owning approximately 141 bulls, with 650 members who own about 6,000 cows.

SCHOOL WORK.

Considerable effort was devoted to work in the public schools in bringing the principles of correct dairy practice before the boys and girls in the rural communities in an interesting and instructive way. Babcock testing for butterfat, the keeping of records of the cows at home, buttermaking, and dairy-cattle judging are useful exercises for school work that have been used successfully in both grade and high schools.

Clubs of boys and girls that perform the duties of cow-testing associations have been organized in several States and have proved successful both in instructing the boys and girls and in interesting their parents in better methods.

COMMUNITY DEVELOPMENT IN DAIRYING.

The project of community development in dairying was transferred from Algona, Iowa, to Grove City, Pa., February 1, 1916, the purpose of the change being to have at the latter place a combination of the three forms of work, farming extension, manufacturing experiment, and laboratory research.

The dairy-farm work was begun last winter in a dairy-farm survey of this community; 135 farms were visited, and tabulations were made regarding their status. Both dairying and general farming in the community are undeveloped, the soil being poor and the buildings inadequate. Most of the farms have no silos or milk houses, and the cattle in use are natives. Prior to the starting of the creamery the market for dairy products was poor, but the creamery has paid good prices, and dairying is rapidly becoming popular. Many silos have been built and there is considerable interest in improved stock. A cow-testing club has been formed, which is expected in time to lead to a regular association. A local bank has arranged to lend money to farmers for the purchase of dairy cattle.

DAIRY DEMONSTRATION FARM, DENISON, TEX.

On the farm near Denison, Tex., owned by local interests and operated under the direction of the Dairy Division for demonstration purposes, the silage crops last year were good, corn and sorghum having yielded 250 tons of silage at the rate of 6 or 7 tons per acre. Marketing conditions have improved, and it has been found possible to market most of the products at fair prices. A commendable interest in good Jersey breeding is shown in the community.

DAIRY MANUFACTURING INVESTIGATIONS.

The work relating to dairy manufacturing is in charge of S. C. Thompson.

CREAMERY INVESTIGATION AND DEMONSTRATION.

The study of creamery problems and the demonstration of proper methods of organizing, building, equipping, and operating creameries have been continued. Four main objects have been kept in view, namely, (1) promoting better business management; (2) increasing the efficiency of operation; (3) improving the methods of manufacturing butter; and (4) encouraging the proper development of the creamery industry.

Monthly circulars supplying valuable and timely information have been sent to creameries and creamery patrons.

Investigation of fuel and power cost in 560 creameries, including 112 this year, has shown much room for improvement in economical operation. Extension work in Minnesota, Wisconsin, Iowa, North Dakota, and South Dakota resulted in the adoption of improved methods in this respect in 33 creameries. Exhaust steam for pasteurizing has proved very economical, saving in some instances as much as 18 per cent on the fuel bill.

During the year 800 creameries sent in monthly reports and 1,061 sent in annual reports, which furnish excellent statistics of the creamery business in the United States. When reports disclosed deficiencies, letters were written by the division giving advice as to means of improvement.

As a result of work of the Dairy Division the profits of nine creameries were increased in amounts varying from \$1,000 to \$5,000.

A cream-grading demonstration at the cooperative creamery at Mora, Minn., showed the advantages of a system of cream grading. The butter was improved from a poor first or second, selling for about 4 cents under New York "extras," to the highest grade on the market, selling for 1 cent above New York extras. This represents to the patrons of this creamery an increased profit of \$3,500 a year.

Assistance has been rendered in establishing creameries in localities where conditions appeared to promise success, and the promotion of creameries was discouraged where the prospects for success were doubtful. New creameries have been assisted until they were able to take care of themselves, and old ones rejuvenated by the introduction of modern methods.

Creamery work in the South has been carried on with the idea of assisting creameries already established to more efficient operation

and of installing the right principles of successful operation in those just starting.

In cooperation with the Office of Markets and Rural Organization, butter from southern creameries has been stored to determine its keeping qualities. Indications so far show no difference as compared with butter of the same quality from other sections of the country.

EXPERIMENTAL CREAMERY AT GROVE CITY, PA.

In last year's report mention was made of an experimental creamery established at Grove City, Pa., by cooperation of local interests with the Dairy Division. The new building was occupied July 19, 1915, and the manufacture of butter was begun immediately. In order to insure the best quality of butter only sweet milk and cream of good flavor are accepted. A complete and simplified system of accounts was installed, with the assistance of the Office of Markets and Rural Organization, and this proved so satisfactory that its general adoption among creameries has been advocated.

Arrangements were made to market the creamery by-products and the farmers' skim milk to the best advantage in the form of cottage cheese, condensed skim milk, and casein, and all these have yielded a substantial profit. The total receipts of the creamery for the year amounted to \$82,432.22.

The business at the Grove City Creamery has been developed in 14 months from one of 3,750 pounds of butterfat a month, delivered by 54 patrons who received \$1,281.05 for their product, to one of 36,777 pounds delivered by 338 patrons who received \$13,551.30. The butter is of such quality that it sells at wholesale in 1-pound prints for 3½ cents above New York extras.

The creamery has furnished a means of carrying on experiments in the making of cottage cheese. As a result of experiments it is now possible to produce an excellent quality of this product, possessing the characteristic flavor and body, from pasteurized skim milk and also from mixtures of up to 50 per cent of buttermilk with skim milk. The pasteurizing temperature recommended is 145° F. for 30 minutes. The buttermilk must be of good quality. The normal temperature for cottage cheese (90° to 110° F.) was found satisfactory, and a yield of from 13 to 22 pounds per 100 pounds of milk was obtained.

Casein of excellent quality also has been made from sweet pasteurized cream buttermilk and skim milk without the addition of chemicals. The method consists of heating the soured buttermilk or skim milk by running it through an ordinary ejector, which causes the curd and whey to separate quickly and thoroughly. Some samples of this casein were tested for paper sizing by a commercial firm, and the results indicate substantial possibilities for profitable disposal of buttermilk casein.

A few small churnings were made under uniform conditions of cream pasteurized when sweet, when mildly sour, and when very sour. Nearly all the butter from the mildly sour and very sour lots of cream had an oily, metallic flavor which was most pronounced in the latter. The losses of fat in the buttermilk of these two lots were noticeably greater than with sweet cream.

The efficiency of pasteurization from a bacteriological standpoint was tested and found to vary in per cent of bacteria destroyed from 99.94 to 99.99.

CHEESE FACTORY INVESTIGATION AND EXTENSION.

Work for the development and extension of cheese manufacture has been carried on. Special attention has been given to extending the industry to new regions where conditions may be favorable, such as the mountainous sections of North Carolina and Tennessee, some of the irrigation projects, and the coast section of the Pacific Northwest. Assistance was rendered to various factories in ascertaining the causes of the poor quality of cheese and to new factories in starting operations with the best methods.

In North Carolina, since this work was begun, 7 cheese factories have been erected, of which 6 were constructed during the past year at an average cost of \$664. They have opened up markets in hitherto undeveloped regions and made possible increased incomes to people far from transportation facilities.

In Montana and Idaho 10 factories were established through assistance furnished by the division, and aid and advice were given to other factories. Most of the new factories which in this section give the best satisfaction to the patrons are cooperative. The cheese production of Idaho increased from 500,000 pounds in 1914 to 1,500,000 pounds in 1915.

A man has been stationed in Tennessee to carry on this work, and requests for assistance have been received from other States.

INSPECTION OF BUTTER FOR THE NAVY.

During the year, under the inspection and supervision of the Dairy Division, 815,125 pounds of butter in 5-pound tins, 63-pound tubs, and 68-pound cubes was packed for the Navy Department.

INSPECTION OF RENOVATED BUTTER.

At the beginning of the fiscal year there were 24 bonded factories for the manufacture of renovated or "process" butter. During the year 2 new factories were started and 2 others were discontinued. The total output was 33,157,536 pounds, a decline of 15.2 per cent from that of the preceding year. Exports of 133,300 pounds were made under certificate, as compared with 1,918,015 pounds in the fiscal year 1915.

Considered as a whole, the sanitary condition of the factories has been improved. One plant has been closed, another has been moved into better quarters, a third has been considerably improved, and a fourth is undergoing extensive repairs.

DAIRY RESEARCH LABORATORIES.

The laboratory work of the Dairy Division is under the direction of L. A. Rogers.

BACTERIOLOGY OF MILK.

Investigations to determine the pathogenicity of the *Bacillus abortus* cultures isolated from the udder have not been entirely conclusive, but it has been shown that in addition to the ordinary pathogenic form there is a fat-splitting type which is found very com-

monly in the udder of healthy cows. The pathogenic type may be converted into the fat-splitting type by continued growth on milk.

The work on the alkali-forming bacteria has been completed by the determination of the source of this group in milk. They come occasionally from feces, but more commonly from soil.

Work of a similar nature has been started on the streptococci occurring in milk, and it has already been found that streptococci from pathological sources are differentiated from ordinary milk streptococci by at least one characteristic.

It has been found that, while there is some variation in the resistance of spores of different species of molds, nearly all of them are killed by the usual pasteurizing temperature of 145° F. for 30 minutes.

The most extensive and important work on the bacteria of milk has been the investigation at Beltsville on the sources of bacteria in milk and the effect of various operations on the number and kinds of bacteria found in fresh milk. This work has established that the important factors in producing milk with a low bacteria count are small-top pails, clean udders, and sterile utensils. The excessive numbers of bacteria sometimes found in market milk are due to multiplication rather than to unusually high initial contamination.

MILK SECRETION.

Laboratory equipment has been installed and some progress made in a study of the changes in the composition of the blood as influenced by the secretion of milk. It has been found that the phosphorus content of the blood changes as the period of lactation begins. The changes in calcium content were not so definite.

CONDENSED MILK.

A 36-inch pan fully equipped for making bulk-condensed milk on a relatively small commercial scale has been installed at the Grove City plant, and is now in successful operation in the making of condensed skim milk. Although the contract for an experimental condensery at Washington was placed a year ago, the installation has just been completed. On account of this delay little progress has been made on the experimental work.

ICE CREAM.

Considerable attention has been given to the problem of storing fat, and it has been found that butterfat may be separated in a fairly pure condition and stored until needed. This fat remains unchanged, and when emulsified with skim milk can hardly be distinguished from fresh cream in the ice cream.

CHEESE INVESTIGATIONS.

SOFT CHEESE.—The work on the soft cheeses has been confined to Roquefort, Cream, Neufchâtel, and a soft cheese made from goats' milk. The method of making and ripening cheese of the Roquefort type has been improved until it is highly probable that domestic cheese can be put on the market in successful competition with the

imported article. Cheese of the Roquefort type made from goats' milk ripens more quickly than that from cows' milk, but otherwise is less satisfactory. A small cheese has been made from goats' milk, furnished by the Animal Husbandry Division, which has some of the characteristics of Camembert and which would probably find a ready market. Bacteriological work has shown that there are bacteria in imported Roquefort cheese which do not occur in similar cheese made in this country, but inoculation experiments have not yet shown that they have any part in the development of flavor.

The rennet, acidity, and temperature for various operations in the manufacture of cheese of the Neufchâtel type have been standardized until it is possible to formulate simple directions for making this cheese.

Swiss cheese.—In the studies to determine the causal agent of eye formation and flavor in cheese of the Swiss or Emmental type, the results indicate a reasonable certainty of the isolation of the bacterium producing the eyes. With this knowledge it is hoped that methods may be developed to insure a uniform quality of cheese that will compare favorably with the imported.

CREAMERY BY-PRODUCTS.

The equipment at Grove City has made it possible to take up in earnest the work on the utilization of by-products of the creamery. Casein made from buttermilk on an experimental scale by a new process has given results comparable with the best grades of skim-milk casein. This method also works satisfactorily with skim milk. The results of this investigation will be prepared for publication.

A method for making cottage cheese with proper control of moisture and texture has been developed. This product permits of the utilization of buttermilk and when a market is available makes a profitable outlet for skim milk and buttermilk.

SILAGE AND FEEDING STUFFS.

The work on the effect of silage on concrete has been completed with the exception of some tests to be made by the Office of Public Roads and Rural Engineering. This year's results show that cement containing 10 per cent of oil is only slightly affected by silage.

The work on losses in silage has been continued with satisfactory results. From the silage put in last year there was collected 10,000 pounds of juice with an average protein content of 1 per cent. This silage was normal and no water was added when it was put into the silo.

The work on the comparison of wood and concrete silos, digestion of starch by young calves, and effect of mineral matter in the ration upon the composition of the milk has been completed and the results are being tabulated.

DISPOSAL OF DAIRY WASTES.

Plans are being made for an experimental plant, to be installed on the Beltsville farm, for the proper disposal of barn washings. At Grove City the experimental plant for waste disposal has been in operation for several months, and notwithstanding the difficulty of

operating the plant without creating a nuisance some very satisfactory results have been obtained. It has been estimated that the total sewage from the creamery has an oxygen requirement for its reduction equivalent to that of the sewage from a village of 1,200 people. A combination of septic tank and sand filter of proper size has given an effluent which could be run on to the land without danger of offensive odors.

MARKET MILK INVESTIGATIONS.

The work in connection with market milk is in charge of Ernest Kelly.

DAIRY SANITATION.

Work has been carried on, as heretofore, to promote the sanitary production and handling of milk. Milk surveys of cities are made, assistance is given to State and municipal boards of health in making regulations for selling milk, and aid is given dairymen in improving conditions and methods used in the production of milk. State and municipal health officers have been very appreciative of this work and have cooperated in carrying it on.

During the year a large number of cities were visited and conferences and demonstrations were held. Actual inspection work, combined with demonstrations in the presence of local inspectors, has been done for the purpose of improving the city milk supply in 21 cities in 17 States. In this work 374 farms and 82 city milk plants were scored, among which were all the certified dairies supplying milk to Chicago.

Milk contests were held in 11 cities in 9 States, and 951 samples of milk and cream were scored.

Aside from these demonstrations and inspections, 31 cities in 16 States were visited to check up previous work, to hold conferences with local officials, and to attend meetings.

Some of this work was done during the summer of 1915, in cooperation with a field party from the Bureau of Chemistry. That bureau made laboratory examinations of milk shipped in interstate commerce; a representative of this division then visited the dairies showing high bacterial counts and suggested changes to improve the quality of the milk.

Milk producers, health officials, milk dealers, and consumers have been brought closer together and a much better understanding has resulted. There is a growing tendency on the part of the dealers to grade milk and to buy and sell on such a basis—a principle strongly advocated by the Dairy Division.

A practical achievement of the year was the devising of a simple and inexpensive steam sterilizer for use on small dairy farms, through the joint efforts of the market-milk section and the research laboratories of the Dairy Division. This sterilizer, which is described in Farmers' Bulletin 748, makes it practicable to sterilize dairy utensils on the farm at very low cost.

Experiments carried on with various strainers for milk indicate that cheesecloth alone is very ineffective. The best results were obtained by using a layer of absorbent cotton between layers of cheesecloth.

The inspection of the milk plants in the District of Columbia for permission to sell milk in Government buildings has been continued, 37 inspections having been made during the year. Counts of bacteria in the milk also have been made. As a result of these inspections only a superior grade of milk is sold in these buildings to Government employees. Inspections and scorings also were made regularly of the dairy experimental farm at Beltsville, Md., and the Naval Academy Dairy at Gambrills, Md.

MILK-PLANT ECONOMICS.

In cooperation with the Office of Markets and Rural Organization an extensive study of the milk supply of Detroit, Mich., was made. The health department and the dealers of that city cooperated fully. Complete data were obtained on about 95 per cent of the total milk supply. The information covered systems of buying, transportation, delivery, accounting, etc., and methods and costs of handling milk, and is being compiled for publication.

Visits were made also to the larger milk-distributing plants in Baltimore, Philadelphia, New York, and Boston, and considerable data were gathered. A special study was made in Buffalo of the system of pasteurizing milk in bottles.

Estimates of equipment have been furnished to nine milk plants varying in capacity from 100 to 1,000 gallons in capacity. With the cooperation of the dairy engineer, plans and specifications have been prepared for a city milk plant capable of handling from 2,500 to 3,000 gallons of milk daily by the gravity system.

The monthly milk-plant letters on timely subjects have been continued and are now sent to 800 addresses.

COST OF MILK PRODUCTION.

Studies in the cost of milk production have been undertaken, and good progress has been made in two States—North Carolina and Indiana. This work includes feed elements, cost, and quality; time required for various operations; cost of clean methods; cost of raising heifers up to time of freshening. A comparison is made also between fall-dropped calves and those dropped in the spring. The investigations have not proceeded far enough for results to be stated.

WESTERN DAIRY INVESTIGATIONS.

The development of dairying in the Western States continues to receive special attention, and is in charge of J. E. Dorman. This work is done in cooperation with extension departments of State agricultural colleges and with county agents, instructors of agriculture in high schools, commercial clubs, city and local boards of health, and other agencies.

DAIRY FARMING.

Dairy Division representatives assisted in the cooperative buying and shipping into western territory of 60 pure-bred dairy bulls and 26 pure-bred and more than 400 grade dairy cows, thus effecting a saving of many hundreds of dollars to the dairymen. This was done

mainly through the cow-testing and bull associations. Many other animals were brought in by individuals.

Seventeen new cow-testing associations were organized and 15 old ones reorganized during the year; at present there are 32 of these organizations. As an indication of the class of men acting as testers it is noted that half of them are four-year graduates from agricultural colleges. Where conditions were such that cow-testing associations could not be formed the keeping of private herd records was encouraged, as a result of which records of production were kept last year for 157 herds, representing 2,709 cows. One new bull association was formed.

Eighty-eight plans for dairy buildings were furnished to prospective builders, of which cost reports have been received for 27 barns, 15 dairy houses, and 7 creameries and cheese factories. The barns constructed are much more convenient and sanitary than those formerly built.

The campaign for more silos, instituted three years ago, has resulted so far in the building of approximately 3,000 silos in the Western States, of which 303 were built during the past year, mostly in territory where silos were unknown.

Besides personal visits, 567 farmers' meetings, with a total attendance of 35,516, were attended by division representatives in the West.

MARKET MILK IMPROVEMENT.

Milk contests, as begun two years ago, are now being held in eight cities in four States. There is an increased interest in them, and their effectiveness as methods of improving the milk supply has been clearly demonstrated. As a result of the interest aroused by the contests, several cities and large distributors have installed laboratories to make systematic inspections. The nature of these contests is such that the dairymen, not knowing when they will be held, are constantly preparing for them by improving conditions. Wide publicity is given to the scores by the newspapers, and since the advertising value of a good score is considerable it keeps up the interest among the producers.

CREAMERIES AND CHEESE FACTORIES.

Three new creameries and four cheese factories were aided in organization. Assistance has been given also to 85 other factories in an effort to improve the quality of their product.

DAIRY INSTRUCTION IN RURAL SCHOOLS.

In 61 rural and high schools in 9 States instruction in some phase of dairying was given by a representative of the division. In Nevada a plan was introduced whereby the boys and girls of suitable age could learn the methods of testing and herd-record keeping as a part of their school course. Testing clubs with a membership of 389 students were formed in 13 schools in connection with this work. Several of the high schools in Utah have been furnished with blanks for the students to use in keeping records, and they have classes working through the summer season.

DAIRY EXPERIMENT FARM.

At the dairy experiment farm at Beltsville, Md., in charge of T. E. Woodward, various improvements have been made, including the laying of 23,506 feet of tile and the grading and surfacing of lots, yards, and roads.

An experiment in grading up scrub cattle by continued inbreeding to pure-bred bulls is progressing well. There are now 30 heifers of the first mating, and all give promise of being considerably superior to their dams.

A number of pure-bred Guernsey heifers purchased last year have freshened, are being officially tested, and are making creditable records.

Results of the comparison of warm and cold skim milk for calves indicate that the former gives the greater gains in live weight with a smaller quantity per pound of gain. No digestive disorders resulted from feeding the cold milk.

An experiment with the open shed versus the closed barn for stabling dairy cows has continued each winter since 1913, and while still uncompleted, the data so far obtained indicate that cows in open shed produced slightly more milk and butterfat, and consumed somewhat more feed, required more bedding, and kept cleaner, than those in the closed barn.

In experiments to test the effect of feed on the quality of milk, bone meal alone was found to have no appreciable effect upon the percentage of fat in the milk. When a group of cows that were fed a ration low in minerals and allowed only three-fourths of the normal quantity of water were compared with a similar group receiving a ration containing bone meal and allowed all the water they would drink twice daily, it was found that the former group produced less milk containing a higher percentage of butterfat than the latter.

Feeding trials indicate that sorghum silage is not equal to corn silage for milk production. It has also been found that for the last two years sorghum yielded 83½ and 96 per cent, respectively, as much silage per acre as corn.

In cooperation with the Bureau of Chemistry experiments have been carried on in feeding potato silage and potato meal to dairy cows. At first most of the cows showed a decided distaste for the potato silage, but after a time they ate it with almost as much relish as corn silage. Feeding trials with the potato meal compared with corn meal have not been completed.

In the comparison of different materials for cow stalls it appears at this time that cork brick will prove to be less durable than creosoted wood blocks, but less porous and hence more sanitary. Concrete floors are more sanitary than either and are more easily cleaned.

DAIRY ARCHITECTURE AND ENGINEERING.

Stock plans and specifications for various kinds of dairy buildings have been prepared and blue prints issued as follows: Dairy barns, 567; milk houses, 233; silos, 117; creameries, 38; manure sheds, 13; ice houses, 8; city milk plants, 5; miscellaneous, 212; total, 1,193. In addition, special plans and specifications were furnished for 1 creamery, 3 cheese factories, and 1 city milk plant. The preparation of such plans is now done in cooperation with the Office of Public

Roads and Rural Engineering. Models of milk houses, cow stables, and equipment were constructed for use in the field. Plans for planting and grading were prepared for the grounds of the Grove City Creamery, and considerable equipment was installed in the creamery and its laboratories. A number of miscellaneous plans and specifications, covering pumps, electrical apparatus, cold storage, and incubator rooms, have been prepared.

A survey of the live-stock farm at New Iberia, La., was made, and plans were furnished for a group of dairy buildings, silage conveyer, sterilizer, and water main, and preliminary sketches were made for three cottages. Surveys and grades were furnished for a part of the sewer system and for grading the roads.

At the Beltsville farm a 30,000-gallon concrete water reservoir and a pump house were constructed and a fire pump installed. This reservoir furnishes fire protection and also supplies the condensing water for the refrigerating plant, and in this way reduces the water consumption from the mains by approximately 4,000 gallons a day. Other work includes the superintendence of the installation of the electrical equipment; surveys and grades for sewers, water mains, and grading; and remodeling a barn.

Assistance was given in the installation of electrical and refrigerating apparatus in the Bureau of Plant Industry and at the Naval Academy dairy farm.

Experiments in pasteurizing and cooling milk in bottles have been completed. A report of this work is in course of publication.

MEAT INSPECTION DIVISION.

R. P. STEDDOM, *Chief*.

The statistics of the Federal meat inspection for the fiscal year 1916 show continued increases in production. More animals were slaughtered under inspection than in any previous year since inspection was begun. There was also a large increase in the amount of meats and meat food products certified for export. The quantity of meats and meat food products processed under bureau supervision shows a very slight decrease because of the increase in that part of the output shipped as fresh meat. The quantity of meats condemned on reinspection was less than in any previous year since 1907.

INSPECTION OF DOMESTIC MEATS.

Inspection was conducted at 875 establishments in 244 cities and towns, as compared with 896 establishments in 247 cities and towns during the preceding fiscal year.

Inspection was begun at 80 establishments and withdrawn from 76 during the year, as compared with 77 and 101, respectively, during the fiscal year 1915. Inspection was withdrawn from 64 establishments because of the discontinuance of slaughtering or of interstate business, from 7 for failure to comply with the department's requirements, from 4 by request, and 1 establishment was consolidated with another.

The ante-mortem inspections, as given in the following table, show a decrease in the number of sheep inspected and an increase for each of the other species, the increase in the total inspections being 7 per cent over the preceding year.

Ante-mortem inspection of animals.

Class of animals.	Passed.	Suspected. ¹	Con- demned. ²	Total in- spected.
Cattle.....	7,337,711	73,741	94	7,411,546
Calves.....	2,038,251	3,758	159	2,042,168
Sheep.....	12,018,634	5,338	6	12,023,978
Goats.....	180,639	132	4	180,775
Swine.....	40,506,775	127,676	11,604	40,646,055
Total.....	62,082,010	210,645	11,867	62,304,522

¹ This term is used to designate animals found or suspected of being unfit for food on ante-mortem inspection, most of which are afterwards slaughtered under special supervision, the final disposal being determined on post-mortem inspection.

² For additional condemnations see succeeding tables.

The post-mortem inspections show an increase of 7 per cent over those of the fiscal year 1915 and an increase of 13.4 per cent over the average for the preceding nine years. While there was a decrease of nearly a million in the number of sheep, there was an increase in all other species, amounting in swine to 11.3 per cent over 1915, which was the largest previous swine-slaughtering year since Federal inspection was begun.

Post-mortem inspection of animals.

Class of animals.	Passed.	Con- demned.	Total.
Cattle.....	7,346,709	57,579	7,404,288
Calves.....	2,041,341	6,681	2,048,022
Sheep.....	11,970,869	15,057	11,985,926
Goats.....	179,693	663	180,356
Swine.....	40,287,692	195,107	40,482,799
Total.....	61,826,304	275,087	62,101,391

The next two tables show the diseases and conditions for which condemnations were made.

Diseases and conditions for which condemnations were made on ante-mortem inspection.

Cause of condemnation.	Cattle.	Calves.	Sheep.	Goats.	Swine.
Acute indigestion.....	1				
Arthritis.....					9
Blackleg.....	2				
Cowpox.....	1				
Dropsical diseases.....					3
Dystokia.....	1				
Emaciation.....	6			4	21
Hog cholera.....					11,430
Immaturity.....		151			33
Injuries.....	8	1	2		5
Moribund.....	12	2			6
Parturient apoplexy.....	2				
Pneumonia, enteritis, etc.....	50	4	4		71
Pregnancy and recent parturition.....	3				
Septicemia.....	3				14
Suspected rabies.....	1				1
Texas fever.....	1	1			
Tuberculosis.....	3				
Tumors and abscesses.....					11
Total.....	94	159	6	4	11,604

Diseases and conditions for which condemnations were made on post-mortem inspection.

Cause of condemnation.	Cattle.		Calves.		Sheep.		Goats.		Swine.	
	Car-casses.	Parts.	Car-casses.	Parts.	Car-casses.	Parts.	Car-casses.	Parts.	Car-casses.	Parts.
Actinomycosis.....	1,200	124,166	16	1,137	.....	1	.....	.....	2	12
Adenitis.....	.....	.....	.....	.....	1	.....	.....	.....	6	35
Anthrax.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Arthritis.....	33	8	.....	7	.....	36	.....	2	10,116	209
Asphyxiation.....	3	.....	1	.....	39	.....	.....	.....	1,042	.....
Atrophy.....	.....	2	.....	1	.....	.....	.....	.....	.....	4
Autointoxication.....	1	.....	.....	.....	15	.....	.....	.....	.....	.....
Blackleg.....	25	.....	7	.....	.....	.....	.....	.....	.....	.....
Bone disease.....	13	4	5	1	.....	3	.....	.....	71	6
Caseous lymphadenitis.....	.....	.....	.....	.....	3,190	19	191	155	.....	.....
Cellulitis.....	.....	.....	.....	.....	.....	.....	.....	.....	42	496
Congestion.....	10	.....	1	.....	.....	.....	.....	.....	13	.....
Contamination.....	2	1,280	14	19	1	83	.....	.....	379	7,492
Cysticercous.....	352	1,165	25	3	380	1	.....	.....	234	.....
Dropsical diseases.....	27	2	9	2	37	.....	.....	.....	64	.....
Emaciation.....	7,122	.....	1,438	.....	3,593	.....	337	.....	948	.....
Exhaustion.....	1	.....	3	.....	6	.....	.....	.....	.....	.....
Frozen.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gangrene.....	50	.....	16	.....	.....	.....	.....	.....	33	.....
Hernia.....	2	.....	.....	.....	3	.....	.....	.....	51	.....
Hog cholera.....	.....	.....	.....	.....	.....	.....	.....	.....	38	.....
Hydronephrosis.....	.....	.....	.....	.....	.....	.....	.....	.....	64,404	.....
Icterus.....	60	.....	67	.....	1,324	.....	24	.....	7	.....
Immaturity.....	.....	.....	1,501	.....	3	.....	5	.....	3,090	.....
Injuries, bruises, etc.....	2,204	541	380	128	627	126	31	1	1,360	8,220
Leukemia.....	342	.....	22	.....	15	.....	.....	.....	167	.....
Melanosis.....	20	4	12	1	12	2	.....	.....	126	.....
Moribund.....	6	.....	7	.....	72	.....	.....	.....	65	.....
Necrobacillosis.....	17	.....	.....	.....	.....	636	.....	.....	4	.....
Necrosis.....	6	647	.....	2	4	.....	.....	1	17	.....
Parasitic diseases.....	6	5	1	.....	22	.....	.....	.....	233	.....
Phlebitis.....	.....	.....	219	.....	.....	.....	.....	.....	.....	.....
Pneumonia, peritonitis, metritis, enteritis, pleurisy, etc.....	5,953	4	1,385	.....	4,983	3	54	.....	20,671	.....
Pregnancy and recent parturition.....	58	.....	.....	.....	50	.....	3	.....	59	.....
Septicemia, pyemia, and uremia.....	1,572	.....	296	.....	576	.....	13	.....	14,122	.....
Sexual odor.....	1	.....	.....	.....	1	.....	3	.....	1,355	.....
Skin diseases.....	.....	.....	.....	.....	.....	.....	.....	.....	27	.....
Texas fever.....	924	.....	539	.....	.....	.....	.....	.....	.....	.....
Toxicosis.....	20	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tuberculosis.....	37,085	58,873	687	453	.....	.....	.....	.....	74,109	519,999
Tumors and abscesses.....	464	2,214	29	234	89	97	2	2	2,185	9,815
Total.....	57,579	188,915	6,681	1,988	15,057	1,007	663	161	195,107	546,290

The following table shows the total condemnations on ante-mortem and post-mortem inspection combined:

Summary of condemnations.

Class of animals.	Animals or car-casses.	Parts.
Cattle.....	57,673	188,915
Calves.....	6,840	1,988
Sheep.....	15,063	1,007
Goats.....	667	161
Swine.....	206,711	546,290
Total.....	286,954	738,361

In addition to the foregoing, the carcasses of 61,991 animals found dead or in a dying condition were tanked, as follows: Cattle, 1,827; calves, 1,434; sheep, 5,167; goats, 154; swine, 53,409.

The inspection of meats and meat food products prepared and processed under the supervision of bureau employees is shown in the following table. This is a record of work done and not a statement of the actual quantity of products prepared. The same product is sometimes duplicated by being reported in different stages of preparation under more than one heading.

Meat and meat food products prepared and processed under inspection.

Kind of product.	Pounds.
Placed in cure—Beef.....	171,438,037
Pork.....	2,922,380,755
All other.....	2,571,739
Sausage chopped.....	565,047,281
Canned product—Beef.....	132,249,254
Pork.....	26,651,409
All other.....	5,299,385
Sterilized product—Beef.....	4,779,570
Pork.....	8,847,245
All other.....	8,800
Meat extract.....	723,479
Steam and kettle rendered lard.....	1,174,350,650
Leaf lard.....	21,547,592
Neutral lard.....	81,971,683
Lard oil.....	5,269,099
Lard stearin.....	4,175,767
Lard compound.....	10,380,896
Compound-lard substitute.....	386,375,898
Bakers' compound.....	487,327
Oleo stock and edible tallow.....	68,587,095
Oleo oil.....	145,653,666
Oleo stearin.....	72,806,678
Oleomargarin.....	151,332,673
Miscellaneous products.....	1,511,157,863
Total weight.....	7,474,093,841

The quantity of meat and meat food products condemned on reinspection because of having become sour, tainted, putrid, unclean, rancid, or otherwise unwholesome, was as follows: Beef, 6,920,972 pounds; pork, 10,818,148 pounds; mutton, 114,741 pounds; veal, 42,412 pounds; goat meat, 1,094 pounds; total, 17,897,367 pounds.

Market inspection was continued at 44 cities, the same number as in the preceding year. This inspection is conducted at the public markets of these cities in order that interstate deliveries may be made in accordance with the Federal meat-inspection law and regulations.

MEAT PRODUCTS CERTIFIED FOR EXPORT.

For the export of meat and meat food products there were issued 124,694 certificates, covering 510,198,401 pounds of beef and beef products, 1,373,321,186 pounds of pork and pork products, and 12,344,349 pounds of mutton, a total of 1,895,863,936 pounds. This is an increase of 36 per cent over the fiscal year 1915 and an increase of 110 per cent over the fiscal year 1914.

In addition there were issued 752 certificates covering the export of 10,335,646 pounds of inedible animal products.

EXEMPTION FROM INSPECTION.

The provisions of the meat-inspection law requiring inspection do not apply to animals slaughtered by farmers on the farm nor to retail butchers and dealers. The department requires that such

butchers and dealers, in order to ship meat and meat food products in interstate commerce, shall first obtain certificates of exemption, but no such requirement is made of farmers. The number of exemption certificates outstanding at the close of the fiscal year was 2,395, an increase of 265 over the preceding year. During the year 156 certificates were canceled, 130 on account of the dealers retiring from business or ceasing to make interstate shipments, and 26 for violation of the regulations. In some cases the certificates were re-issued when the business was resumed or when the insanitary conditions had been corrected.

During the fiscal year 79,629 shipments were made by retail dealers and butchers holding certificates of exemption, as compared with 84,769 shipments in the fiscal year 1915. The shipments of the year covered products as shown in the following table:

Shipments by retail dealers and butchers under certificates of exemption from inspection.

Product.	Number.	Pounds.
Beef, carcasses (1,724 quarters).....	431	191, 971
Calves, carcasses.....	41, 048	3, 964, 660
Sheep, carcasses.....	2, 155	93, 910
Swine, carcasses.....	1, 684	173, 751
Beef, fresh.....		1, 625, 823
Veal, fresh.....		337, 126
Mutton, fresh.....		491, 150
Pork, fresh.....		328, 231
Cured meats.....		577, 139
Lard.....		60, 113
Sausage.....		140, 830
Miscellaneous (scrapple, tripe, head cheese, etc.).....		48, 931
Total.....	45, 318	8, 033, 635

During the fiscal year 89,579 interstate shipments were made of meats and meat food products from animals slaughtered by farmers on the farm, as compared with 78,026 shipments during the fiscal year 1915. The following table shows the products covered by these shipments:

Shipments of farm-slaughtered products under exemption from inspection.

Product.	Number.	Pounds.
Beef, carcasses (4,104 quarters).....	1, 026	403, 058
Calves, carcasses.....	102, 847	11, 734, 637
Sheep, carcasses.....	7, 771	284, 285
Swine, carcasses.....	23, 730	2, 547, 870
Beef, fresh.....		17, 911
Veal, fresh.....		100, 838
Mutton, fresh.....		2, 707
Pork, fresh.....		192, 075
Cured meats.....		1, 018, 283
Lard.....		231, 117
Sausage.....		134, 898
Miscellaneous (scrapple, tripe, head cheese, etc.).....		41, 176
Total.....	135, 374	16, 708, 855

INSPECTION OF IMPORTED MEATS.

The following table shows the inspection of imported meats and meat food products for the fiscal year, and indicates a decrease of 55 per cent as compared with the fiscal year 1915:

Imported meat and meat food products inspected.

Country of origin.	Fresh and refrigerated meats.		Cured and canned meats.	Other products.	Total weight.
	Beef.	Other classes.			
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Argentina.....	61,414,468	20,156,442	751,186	537,087	82,859,183
Australia.....			94,404	17,876	112,280
Brazil.....	7,040,684		3,600		7,044,284
Canada.....	10,170,911	2,385,058	1,607,539	611,863	14,775,371
Mexico.....	1,301,192				1,301,192
New Zealand.....			6,347		6,347
Uruguay.....	2,944,972	782,678	39,889	167,006	3,934,545
Other countries.....	11,776	98	240,313	229,087	481,274
Total.....	82,884,003	23,324,276	2,743,278	1,562,919	110,514,476

The following statement shows the condemnations of imported meats and the amount refused entry on account of lack of foreign certificates or other failure to comply with the regulations:

Import meat products condemned or refused entry.

Product.	Condemned.	Refused entry.
	<i>Pounds.</i>	<i>Pounds.</i>
Beef.....	283,448	104,807
Veal.....	914	
Mutton.....	1,923	
Pork.....	11,991	9,100
Total.....	298,276	113,907

INSPECTIONS FOR THE NAVY AND OTHER GOVERNMENT BRANCHES.

By request inspections of meat and meat food products, to determine whether they conformed to the specifications, have been made during the year for certain branches of the Government, as follows: For the Navy 14,016,818 pounds were inspected, of which 471,464 pounds failed to come up to the requirements. For the Army 86,874 pounds were inspected and all passed. For the Interior Department (Office of Indian Affairs) 211,157 pounds were inspected, of which 6,378 pounds were rejected. For the Alaskan Engineering Commission 21,307 pounds were inspected, of which 1,500 pounds were rejected.

MEAT-INSPECTION LABORATORIES.

In the laboratories maintained for the meat-inspection samples of all meat-food products prepared at establishments where Federal inspection is maintained have been analyzed to determine whether they were properly labeled or contained any harmful substance. Samples of the various materials used in the curing and preparation of meat and products, such as water and spices, and samples of materials such

as inks and insect and rodent exterminators intended for use in or around official establishments were also examined, and permission for their use was based upon the results of such examinations.

Samples to the number of 55,423 were analyzed, of which 54,681 were domestic and 742 imported products. This represents an increase of approximately 20,000. Eighteen hundred and forty-four samples were found not to be in accordance with the regulations. Water supplies from 433 sources were examined, 53 of which were condemned for use in the preparation of meat products.

The scarcity of saltpeter has necessitated the use of Chile saltpeter (sodium nitrate) as a substitute in the curing of meats. Since borax commonly occurs as an impurity in crude Chile saltpeter, considerable attention was given to the sampling and examining of samples of this material. A large number of samples of this sort were found to contain borax and were rejected for use in the curing of meats.

Very few samples of meat food products were found to contain prohibited preservatives that had been intentionally added. In cases where preservatives were encountered their presence was usually found to have been due to the use of a curing mixture containing the preservative as an impurity. The most apparent violations of the regulations as disclosed by the examination of samples of meat food products consisted in improper labeling, while the more common causes of condemnation of fats and oils were rancidity and acidity. The examination of spices, condiments, and gelatins showed that great improvement has been made in the quality of these materials.

FIELD INSPECTION DIVISION.

R. A. RAMSAY, *Chief.*

The work of eradicating foot-and-mouth disease, already reported, was carried out mostly through this division.

ERADICATION OF SOUTHERN CATTLE TICKS.

As the result of the work done in cooperation with authorities of various Southern States for the extermination of the ticks which spread the infection of splenic fever in cattle, areas aggregating 31,358 square miles, as shown by the following table, were released from quarantine during the fiscal year. The total area released since the beginning of this work in 1906 amounts to 284,521 square miles, being a territory greater in size than the combined areas of Tennessee, Mississippi, Alabama, Georgia, Florida, and South Carolina. The work is also far advanced in a large additional territory.

Areas released from splenic-fever quarantine as a result of eradicating cattle ticks, fiscal year 1916.

State.	Square miles.	State.	Square miles.
Alabama.....	6,742	North Carolina.....	2,720
Arkansas.....	1,672	South Carolina.....	5,457
Florida.....	3,800	Texas.....	1,387
Georgia.....	4,822	Virginia.....	47
Louisiana.....	420		
Mississippi.....	4,291	Total.....	31,358

During the year 16,281,185 inspections were made of cattle for ticks, as against 11,268,668 in the preceding year. There were in operation 12,662 cattle dipping vats, where cattle were dipped under Federal or State supervision to rid them of ticks.

In addition to the large number of inspections made and dippings supervised, a great deal of preliminary and demonstrational work was conducted by bureau employees to teach cattle owners the desirability and importance of eradicating the cattle ticks and to show them the best methods to pursue. This work is done in cooperation with State authorities and is being pushed forward as rapidly as possible with the means at hand. Very effectual cooperation has come from transportation companies, commercial clubs, bankers, and other business men who are farsighted enough to realize that the eradication of the cattle tick and the subsequent development of the live-stock industry means an increase of business for all concerned.

INTERSTATE TRANSPORTATION OF LIVE STOCK.

The number of cattle shipped from the area quarantined for splenic or tick fever to market centers outside of the quarantined area was 502,393, as compared with 845,059 during the fiscal year 1915. This was a decrease of 40.54 per cent in the number of tick-infested cattle shipped from the quarantined area for immediate slaughter. There were reshipped from the quarantine pens at market centers to points where southern cattle are permitted to be shipped for immediate slaughter 113,085 head, being a decrease of 49.64 per cent from the preceding year.

The number of cattle of the quarantined area dipped and certified for movement as noninfectious was 216,943, an increase of 74.53 per cent. Of this number, 124,295 were dipped a second time, in order that they might be disposed of for purposes other than immediate slaughter. During the year 3,178 certificates were issued for shipment to markets of free cattle and those dipped or otherwise treated as provided for in the regulations.

There were also dipped, on account of splenic-fever ticks, 586 horses and mules, certificates for the interstate movement of which were issued.

There were inspected, at market centers and elsewhere, for scabies and other contagious diseases, 14,451,291 cattle, of which 7,942 were dipped under bureau supervision, in order that they might continue in interstate transit.

Sheep to the number of 20,538,977 were inspected at stockyard centers for scabies and other contagious diseases, and 868,689 were dipped under bureau supervision, in order that they might be disposed of for purposes other than immediate slaughter.

ERADICATION OF SHEEP SCABIES.

The number of inspections of sheep by bureau employees for the eradication of sheep scabies in the area quarantined for that disease was 19,555,969. Sheep to the number of 6,473,419 were dipped for scabies in the quarantined area, in cooperation with the State officials.

As a result of this work, sheep scabies is being fast eliminated from the sheep of Western States. During the fiscal year 43,243 square miles in the State of California were released from quarantine.

ERADICATION OF CATTLE SCABIES.

The number of inspections of cattle by bureau employees for the eradication of cattle scabies in the area quarantined for that disease was 2,934,098, an increase of 132.12 per cent. In cooperation with State officials 691,715 cattle were dipped for scabies in the area under quarantine. During the fiscal year 12,691 square miles in the State of Texas were released from quarantine.

SCABIES IN HORSES.

The number of horses and mules inspected for scabies was 350, of which 100 were dipped twice.

INSPECTION OF ANIMALS FOR INDIAN AGENCIES.

In cooperation with the Office of Indian Affairs of the Department of the Interior, 632 horses and mules were inspected and 508 passed for allotment to the several Indian agencies. Likewise, 2,676 cattle were inspected and 2,166 passed.

LIP-AND-LEG ULCERATION IN SHEEP.

Inspections for lip-and-leg ulceration of sheep were made at market centers in connection with inspections for other infectious and contagious diseases of animals, and 1,469 sheep were found to be infected with and 1,960 to have been exposed to this disease, and were disposed of in accordance with the regulations.

INSPECTION AND TUBERCULIN TESTING OF CATTLE FOR INTERSTATE MOVEMENT.

There were inspected by bureau veterinarians, in compliance with the laws of the States to which the animals were destined and upon request of transportation companies or cattle owners, 82,613 cattle moving interstate for purposes other than immediate slaughter, of which 32,979 were tested with tuberculin. Of the number tested, 1,174 were found to be diseased with tuberculosis and 159 showed temperatures which required them to be held as suspects for further examination.

INSPECTION AND MALLEIN TESTING OF HORSES AND MULES FOR INTERSTATE MOVEMENT.

There were inspected by bureau veterinarians, in compliance with the laws of the States to which the animals were destined and upon request of transportation companies or shippers, 34,086 horses and mules, 6,594 of which were tested with mallein, 6 showing typical reactions to the test and 6 such increase in temperature that they were held for further examination.

IMMUNIZATION OF SWINE AGAINST HOG CHOLERA.

Swine to the number of 56,494 were inspected, and under the bureau's supervision were given the immunization treatment against hog cholera for interstate shipment from public stockyards.

CLEANING AND DISINFECTING CARS.

There were reported by bureau stations as arriving at points where bureau inspection is maintained 23,252 cars carrying animals affected with a contagious, infectious, or communicable disease. During the year 136,580 cars were cleaned and disinfected under bureau supervision because of bureau regulations or upon request of Canadian Government officials, State officials, or transportation companies.

VIOLATIONS OF LIVE-STOCK TRANSPORTATION AND QUARANTINE LAWS.

The bureau has continued to report to the solicitor of the department, for presentation to the Attorney General for prosecution, cases of apparent violation of live-stock transportation and quarantine laws. Many of these cases have required special investigation on the part of bureau employees, such as interviewing witnesses and examining railroad and other records for the completion of evidence. Six bureau employees are regularly assigned to this work, though the greater part of the work of collecting evidence and preparing and submitting reports is done by bureau employees at stockyard centers in connection with their other duties.

QUARANTINE DIVISION.

R. W. HICKMAN, *Chief*.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

As a result of the ports of this country having been closed against importations from Great Britain on account of outbreaks of foot-and-mouth disease in England during a period of approximately six months, importations were again below the normal average. Following the expiration of 90 days after the destruction of the animals on the last premises to become infected with foot-and-mouth disease in Great Britain the department resumed the issuance of permits in April, 1916, for the importation of ruminants and swine from the United Kingdom.

The following tables show the importations of the various classes of live stock through the different ports of entry:

Imported animals inspected and quarantined.

Port of entry.	Cattle.	Sheep.	Swine.	Other animals.
New York.....	730		10	93
Boston.....	79	303	8	
Baltimore.....	181			
San Francisco.....		156		443
Canadian border ports.....	4,428	114	47	330
Total.....	5,418	573	65	866

Imported animals inspected but not quarantined.

Port of entry.	Cattle.	Sheep.	Swine.	Horses.	Goats.	Other animals.
New York.....				796		
Boston.....		100				
Philadelphia.....						15
New Orleans.....	2,183			336		
San Francisco.....		138		3		
Tampa.....				13		
Key West.....				303		
Mexican border ports.....	205,390	140,681	1,077	12,776	101,786	12
Canadian border ports.....	241,663	72,678	3,693	10,193	11	200
Total.....	449,236	213,597	4,770	24,420	101,797	227

The bureau's inspectors stationed in Great Britain have continued, when requested by prospective importers, to apply the tuberculin test to cattle for shipment to this country. Cattle not so tested before importation are tested in quarantine after arrival in this country. Results of tests are shown in the following table:

Results of tuberculin tests of cattle for importation into the United States.

Breed.	Tested in Great Britain.		Tested in quarantine.	
	Passed.	Failed.	Passed.	Failed.
Ayrshire.....	26	2	2	
Aberdeen Angus.....	4			
Guernsey.....	263	5	154	
Hereford.....	59			
Jersey.....	274	4	59	
Shorthorn.....	61	21		
Total.....	687	32	215	

IMPORTATION OF HIDES, WOOL, HAY, STRAW, ETC.

Supervision is exercised over the importation of hides, glue stock, horns, bones, hair, wool, hay, straw, and forage, with the object of preventing the entrance of the infection of anthrax or other communicable diseases.

Direct importations of hides have been much heavier during the past fiscal year, owing largely to changes in shipping incident to the war in Europe. Such importations have been governed by regulations issued by the Treasury Department, in the enforcement of which the Bureau of Animal Industry cooperates.

INSPECTION OF VESSELS AND EXPORT ANIMALS.

There has been continued activity in the exportation of horse stock, and following the eradication of foot-and-mouth disease in this country a resumption of the usual export shipments of ruminants and swine.

Two hundred and twenty-three inspections of vessels carrying live stock were made before clearance, and 151 certificates of inspection

were issued for American cattle, sheep, swine, and horses for shipment to foreign countries.

The shipments of horses and mules to Europe, for the demands of the armies, have continued heavy. There were 462 vessels carrying horses and mules to Europe, and while these are not subject to inspection by this department, a general supervision is maintained over the fitting of the vessels and the placing of the animals on board, with a view to influencing an observance of the department's requirements for the humane handling and safe transport of horse stock as provided by the regulations (B. A. I. Order 139).

The mallein test was applied to 4,159 horses and 4,758 mules for shipment to Canada, in accordance with requirements of the Canadian regulations governing the entry of horse stock into that country. Twenty-one of these animals reacted to the test and were rejected for shipment. Also, 489 cattle were tested with tuberculin for shipment to Canada, with 6 reactions; and inspections were made of 454 sheep and 72 swine.

For shipment to the Hawaiian Islands, 111 cattle were tested with tuberculin, of which 3 reacted; the mallein test was applied to 117 horses and 624 mules, of which none reacted; and inspections were made of 10 goats and 14 swine.

For shipment to other countries, 139 cattle were tested with tuberculin, and 15 reacted. Eight horses, 44 swine, and 8 sheep were inspected.

There were shipped to European ports via Canada, without bureau inspection and certification, 4,341 mules, under a provision of the department regulations permitting such shipment, at shipper's risk, to countries which do not demand such inspection and certification as a prerequisite to admission.

The following table gives statistics of inspections of live stock for export:

Inspections of American and Canadian animals for export.¹

Kind of animals.	American.	Canadian.
Cattle.....	11,628	293
Sheep.....	872	
Swine.....	251	
Horses.....	298,193	1,765
Mules.....	100,422	
Goats.....	19	
Total.....	411,385	2,058

¹ This table includes horses and mules exported to Europe for army use, which animals were inspected chiefly by officials of the countries to which they were consigned.

COOPERATIVE TUBERCULOSIS INVESTIGATIONS.

The cooperative work for the suppression of cattle tuberculosis has been continued with the owners of herds of cattle in different States, with the Dairy and Food Division of the State of Virginia, with the Commissioners of the District of Columbia, and with the

Office of Indian Affairs of the Department of the Interior. Each year shows a marked increase in this work.

The establishment of pure-bred herds of cattle free from tuberculosis as determined by tuberculin tests applied under bureau supervision is being materially realized by the tuberculin testing of such herds in widely separated sections of the United States.

The cooperation with the Office of Indian Affairs is resulting in the eradication of tuberculosis from many of the herds at the Indian schools and in an improvement in the quality of cattle and the sanitary conditions under which milk is produced.

In the District of Columbia, where a compulsory tuberculin test has been a requirement since November, 1909, the work has been continued with cooperation upon the part of private cattle owners and of the cattle dealers. The success of this method of controlling bovine tuberculosis in a restricted area is clearly demonstrated, as the percentage of this disease in the District has been reduced within seven years from 18.87 to 1.1 as shown by a complete testing of all cattle in the District of Columbia during the past year.

The continuation of cooperation with Virginia farmers and the Virginia Dairy and Food Division is making strong inroads against the prevalence of bovine tuberculosis in that State, as shown by a reduction in the percentage of cattle submitted to the tuberculin test for the first time to 7 per cent as compared with 18.27 per cent in 1910.

The following statement shows numerically the results of the tuberculin test applied in the District of Columbia, Virginia, and Maryland:

Results of tuberculin testing of dairy cattle in Maryland, Virginia, and the District of Columbia.

State or district.	Total.	Passed.	Reacted.	Percentage of reactors.
Virginia:				
Original tests	3,852	3,579	273	7.08
Annual retests	7,785	7,507	278	3.57
Total	11,637	11,086	551	4.7
Maryland:				
Original tests	272	245	27	9.9
Annual retests	1,266	1,234	32	2.53
Total	1,538	1,479	59	4.34
District of Columbia	1,184	1,173	11	1.1
Grand total	14,359	13,738	621	4.3

ERADICATION OF DOURINE.

Two-thirds of a special appropriation of March 4, 1915, or the sum of \$50,000, became available for the eradication of dourine of horses at the beginning of the fiscal year. Practically all of this amount was expended on this work in the various States by the close of the summer season of 1915, and as no special appropriation was made during the year, it was not possible to place an adequate force of

inspectors in the field during the last three or four months of the fiscal year. This was somewhat unfortunate, as the testing of stallions and mares is accomplished to the best advantage prior to the breeding season and the inspection of such animals during the round-up period insures the greatest degree of cooperation between the bureau inspectors and horse breeders.

This disease has been found to be much more widely distributed among horses in some States than was at first believed. Notwithstanding this increased area of infection and the lack of funds for use during the latter part of the year, good results have been accomplished in the work of eradicating the disease in Montana, Wyoming, North Dakota, South Dakota, Nebraska, and Arizona. There has been a satisfactory cooperation with the bureau on the part of the various State officials and horsemen concerned, and as funds have been available the bureau has continued the practice of paying one-half of the appraised valuation of infected horses destroyed, such share not exceeding \$100 in any one case.

The number of animals tested and the results of the tests are reported under the heading of the Pathological Division. The percentage of reactions is 3.1, as compared with 2.7 for the previous fiscal year. This increase is due to the spread of the disease among the horse stock of the Indian reservations and to the lack of available funds to prosecute the work vigorously, especially at the beginning of and throughout the round-up season in the spring and early summer; also to the fact that the work of eradication extended to certain infected areas in which it has not previously been conducted.

PATHOLOGICAL DIVISION.

ADOLPH EICHHORN, Chief.

ANTHRAX INVESTIGATIONS.

Further experiments have confirmed the efficacy of the combined serum and spore vaccine treatment of anthrax. Some of this work has been reported in Department Bulletin 340, "Experiments in Vaccination against Anthrax," by Adolph Eichhorn. Later research work has been directed toward improving the process and gaining more exact knowledge.

During the year approximately 7,500 doses of anthrax serum and spore vaccine for the simultaneous method of immunization against anthrax have been prepared by this division and used in the control of outbreaks in various parts of the United States. Reports on the use of these products fully establish the value of this method of immunization. A considerable quantity of the serum was supplied for the treatment of anthrax in man and animals, and proved a valuable remedy. Manufacturers of biological products are now preparing to market anthrax serum and spore vaccine, and in a short time the simultaneous method of immunization against anthrax will, no doubt, be generally available.

Bacteriological examinations of tannery refuse and of sewage for the presence of anthrax organisms have been made, and positive results were obtained in several instances. A bacteriological exami-

nation of hay cut from swampy meadows proved it to be the source of infection in an outbreak of anthrax investigated by the bureau. A number of outbreaks of anthrax in various parts of the country have been investigated and measures taken for control in cooperation with State officials.

CEREBROSPINAL MENINGITIS OR FORAGE POISONING.

Sporadic outbreaks of forage poisoning or cerebrospinal meningitis of horses were studied in the tidewater sections of Maryland and Virginia in the fall and winter. Excellent material for study was obtained, and various experiments were made by inoculating culture media in the laboratory and by feeding and inoculating animals.

Intestinal contents of horses killed while in a dying condition with the natural affection were used to drench well horses at the Bethesda Experiment Station, but with negative results. Laboratory experimental animals fed with feed purposely contaminated with this intestinal material remained well. Work on the disease has been continued in cooperation with the Bureau of Chemistry, and further feeding tests have been conducted with damaged, immature, and moldy corn, but with the usual negative results.

The similarity of some of the symptoms of the disease of horses to botulism of man suggested experiments with a strain of *Bacillus botulinus* known to possess pathogenic qualities, and horses and donkeys were fed with feed contaminated with minute quantities of the culture and toxin, with fatal results. The facts disclosed are very significant, in that a disease is induced which in some respects closely resembles forage poisoning, but additional work will be required to place this disease definitely and to prove or disprove its relationship to the spontaneous forage poisonings met with so frequently in veterinary practice.

DOURINE INVESTIGATIONS.

The complement-fixation test for dourine has continued to be extensively employed for diagnosis, 45,100 samples of blood serum having been received and diagnosed by this method, of which 1,400, or 3.1 per cent, gave positive reactions.

During the year the microscopic agglutination test for the diagnosis of dourine was devised, using as agglutinating fluid a suspension of live trypanosomes. This test was used as a supplementary test to the complement fixation, and is of particular value in certain cases, greatly facilitating the rapid diagnosis of the large number of samples tested.

GLANDERS INVESTIGATIONS.

The complement-fixation test for glanders was applied to the serum of 1,647 animals, of which 253, or 15 per cent, gave positive reactions.

Cooperative work in the control of an outbreak of glanders at Newport News, Va., from which point a large number of horses and mules were shipped abroad, was carried on. About 300 samples of blood serum were tested by the complement-fixation test. The post-mortem examinations substantiated the results of the serum test in practically every case.

Work on the conglutination test for the diagnosis of glanders was begun with particular reference to the applicability of this test to mules. As mule serum is strongly anticomplementary, unsatisfactory results are obtained at times with the complement-fixation test. The results obtained so far are encouraging and indicate the conglutination test to be not only specific but of particular value in the testing of sera possessing anticomplementary or nonspecific fixing bodies. This work is being continued.

HEMORRHAGIC SEPTICEMIA.

During the fall and winter numerous reports were received of heavy losses among stocker cattle in some of the large cattle markets of the Middle West. From specimens of diseased lung that were received pure cultures of the micro-organisms causing the disease were obtained from material originating in 14 different States, from horses, cattle, hogs, sheep, goats, and wild rabbits. The disease was carried from point to point chiefly by young cattle ranging from 8 to 20 months of age and almost invariably by animals that were in very thin flesh. Apparently gaining their infection at the stockyards, these young cattle transmitted the disease in a few instances to hogs or sheep upon the farms to which they were shipped.

The organism that caused the outbreaks in the majority of the cases examined proved on bacteriological investigation to belong to the true hemorrhagic septicemia group. A few of the others were caused by organisms that approached the *Bacillus paratyphus* B in character.

Encouraged by the gratifying results derived in 1911 from the use of bacterins on buffaloes in the Yellowstone National Park, bacterins were prepared from the cultures recovered from cases of hemorrhagic septicemia of cattle and sheep during the current year, and several available droves of infected young cattle were injected experimentally. Test animals at the laboratory and others at Bethesda Experiment Station were immunized. From the results obtained during these investigations and in the field it appears evident that outbreaks of hemorrhagic septicemia in cattle and sheep may be frequently checked by injecting all susceptible animals upon the premises on which the disease has appeared with effective bacterins.

The complement-fixation test proved very reliable in the diagnosis of hemorrhagic septicemia in all species of animals.

ABORTION DISEASE.

The investigation and control of bovine infectious abortion has been continued with definite progress. A voluminous correspondence has been the means of disseminating information to all parts of the country and the agricultural press has been used to correct certain misconceptions. This correspondence has also furnished information concerning the distribution of abortion. The outstanding feature has been the exceedingly rapid spread of this disease among range animals.

Serological tests for diagnosis of abortion were applied in approximately 1,300 cases. These tests were used extensively also in

experimental work. Cooperative work was carried on with the Virginia and Delaware Agricultural Colleges and the New York State Veterinary College. Experimental treatment of infected herds with biological products was undertaken, but sufficient time has not elapsed to allow the drawing of definite conclusions. Immune serum, for experimental use, is being produced at the Bethesda station, and results of scientific interest have been obtained.

Results obtained in the use of various methods of control indicate that sanitary measures and control of breeding are still the most reliable means of combating the disease, and literature giving details of this system of treatment has been widely disseminated.

The correspondence seems to indicate that equine abortion is also on the increase, but not to the same degree as bovine abortion. A few reports of abortion in hogs were received. Inasmuch as the disease in these species manifests itself similarly to bovine abortion and is transmitted by the same agencies, the same methods of sanitation and breeding control are advocated.

SWAMP FEVER INVESTIGATIONS.

An experiment in insect transmission of swamp fever or infectious anemia of horses with *Tabanidæ* flies was entirely negative. A healthy horse was exposed to the bites of flies which had access to a horse having a case of natural infection and which had been under observation at the station since 1909, yet the disease was not transmitted. The continued infectiousness of the blood of the infected animal was nevertheless afterwards proved by inoculation of the other horse. During the six years that the infected horse has been kept, both *Tabanus* and *Stomoxys* flies have been seen in the stalls during the summer season, yet no spontaneous cases of the disease have developed in exposed healthy horses.

Experiments in serodiagnosis have not yielded a satisfactory diagnostic procedure.

The increasing economic importance of the disease is evidenced by the fact that it has gained a foothold in New York, where it was not recognized prior to 1914.

AMEBIC DYSENTERY.

An opportunity was presented to study a spontaneous outbreak of disease in monkeys in which the lesions observed corresponded quite closely with those found in amebic or tropical dysentery of man. Protozoan organisms were found having the general structure and characteristics of the amebas generally considered the causative agents of human tropical dysentery. The disease prevailed among a group of spider monkeys kept in a large exhibition cage at the National Zoological Park, and during the course of three months nine monkeys became affected, eight of which died of dysentery. Marked lesions were present in the large intestine and in two instances liver abscesses were observed. The amebas were numerous in both intestinal and liver lesions.

This outbreak is of special interest, since there appears to be no similar case recorded, and because our knowledge of the occurrence of this disease in animals is very meager. It seems probable that the affection was introduced with imported monkeys. The possibility of

transmission of this ameba to human beings through such sources must be given cognizance.

RABIES.

The examination for rabies included many suspected cases from Maryland, Virginia, and Kentucky, as well as the District of Columbia. One hundred and thirty-five suspected cases were received for laboratory diagnosis. The diagnosis was positive for 54 dogs, 7 cats, 4 cattle, 1 horse, and 1 mule, a total of 67 positive cases. In three of the cases the material was so decomposed that no diagnosis was possible. In every instance where a person was bitten, animal inoculation was resorted to when the microscopic findings were negative.

Experiments conducted on a limited number of animals, including dogs, sheep, and calves, with a view to determining the immunizing power of rabies vaccine prepared after the Harris method, and of dilutions of fresh fixed virus, have yielded some promising results. This work, however, has not as yet afforded sufficient data on which to base definite conclusions.

TESTS FOR TUBERCULOSIS.

In the testing of dairy cattle in various sections of the country with tuberculin by means of subcutaneous injections, among the large number of reactors there were 83 cattle that had apparently reacted to the test and which were slaughtered under Government supervision but in which at the time of inspection no visible lesions of tuberculosis could be demonstrated. Lymph glands from these cattle were forwarded to the pathological laboratory, where they were first tested microscopically, and if no tubercle bacilli were detected by this procedure the glands were further tested by animal inoculation. As a result 36 of the uncertain cases proved to be tuberculosis, while in 47 no evidence of tubercle bacilli was discovered.

The intradermal palpebral method of applying tuberculin has been giving excellent results in recent tests, and it has been suggested that its use in retesting cattle that have given an uncertain reaction to the subcutaneous injection of tuberculin might prevent the unnecessary slaughter of animals that are not visibly affected with tuberculosis. In this method the same technique is followed as in making intradermal injections into one of the subcaudal folds, except that the needle is inserted into the lower eyelid, at a point near its middle, longitudinally, and about half an inch from its margin. Bureau tuberculin, concentrated to 50 per cent of its original volume, was selected as the best form of tuberculin for intrapalpebral use. One-fifth to one-fourth of a cubic centimeter constitutes a suitable dose. A reaction is manifested by a swelling of the lid which becomes very apparent, so that the results of the test may be read from a distance. As the reaction is produced automatically, no errors need be made in interpreting results.

Extensive investigations have been made into the reliability and practicability of the complement-fixation test in the diagnosis of tuberculosis. Eight hundred and sixteen samples of blood from cattle were examined, most of them coming from animals that were afterwards slaughtered under Federal supervision. Out of 320 negative sera, a total of only 279 (85.9 per cent) proved distinctly negative

to the test, whereas of 360 positive sera, 290 (80.5 per cent) were positive. Furthermore, of the affected animals 81 (25.8 per cent) gave only slight positive reactions, and 80 were atypical. The grand total of 81.6 per cent of accurate reactions obtained is by no means sufficient to make the test practicable for the control of the disease, especially since the allergic tests which we have at our command are more reliable. No satisfactory explanation can be given as to the failure of reactions in known tuberculous infections or for the positive reactions in apparently healthy individuals. There exists a possibility, however, that some of the positive reactions in the negative cases may have been due to a previous tuberculinization of the cattle, since the histories of the animals furnishing the sera were not available.

BLACKLEG VACCINE.

During the fiscal year 5,436,221 doses of blackleg vaccine were distributed by the bureau, an increase of nearly 2,000,000 doses over the preceding year. A concrete building has been provided at the experiment station for handling the calves from which the virus is obtained. This adds materially to the facilities for preparing the vaccine.

SUPERVISION OF BIOLOGICAL PRODUCTS.

In the enforcement of the virus-serum-toxin law of 1913 the pathological division has continued to exercise supervision over the preparation of biological products, with the exception of anti-hog-cholera serum, hog-cholera virus, tuberculin, and mallein, the work regarding which has been conducted by the Biochemic Division. The supervision of the Pathological Division has covered 154 products made by 22 firms and 17 products imported by 2 firms. An annual inspection is made of the laboratories and the methods employed in preparing and testing these products. Suggestions have been made to the various firms regarding methods for securing greater accuracy in identifying cultures, methods of testing products for sterility, and keeping laboratory records.

From time to time samples of the various biological products manufactured by firms throughout the country are purchased in the open market, and systematic tests are made for sterility, potency, etc. Most of the specimens examined during the past year proved satisfactory. However, in several instances such defects as contaminations, vaccines possessing too great a degree of virulence, etc., were detected. In such cases the matter was taken up with the manufacturers and steps were taken to prevent recurrences.

AUTOPSIES ON ANIMALS FROM THE NATIONAL ZOOLOGICAL PARK.

Autopsies were made on 115 wild animals from the National Zoological Park. More than 50 per cent of the deaths were due to diseases of the digestive and respiratory tracts. In birds the former system is most often attacked, while in mammals it is the latter. Of the infectious diseases tuberculosis plays the most important rôle, there being 8 cases in birds and 4 in mammals. Aspergillosis of the lungs and air sacs was found in 5 birds.

POULTRY DISEASES.

An extensive outbreak of birdpox in a lot of 400 quail gave opportunity to investigate this disease, especially in the relationship between the disease in wild birds and in the domestic fowl. Transmission experiments showed that while fowls contracted the affection, the lesions were not as severe as those following infection by chicken-pox virus.

Attempts to produce an active immunity against fowl cholera were carried out on a large scale, a living, nonvirulent fowl-cholera organism being employed for the purpose. Treated fowls and small experiment animals resisted high dilutions of a virulent strain of the fowl-cholera bacillus when given by hypodermic injection, but except in several instances failed to resist doses of from 1 to 0.01 c. c. of a 48-hour bouillon culture. However, it is doubtful if birds are ever exposed to such large amounts of infectious material in natural outbreaks of fowl cholera.

Work was continued on the development of a practical test for the diagnosis of *Bacillus pullorum* infection in fowls. Results are encouraging, but the investigation has not progressed sufficiently to enable us definitely to determine the accuracy of the test for the detection of the disease in all its stages. Since the localization of this bacillus in the ovary of laying hens is responsible, through the medium of the egg, for the extensive outbreaks of the highly fatal bacillary white diarrhea of baby chicks, it is of great importance that a simple, inexpensive test be developed for the purpose of detecting and weeding out the infected fowls.

INVESTIGATIONS OF PLANT POISONING OF STOCK.

The work relating to the plant poisoning of stock was transferred to the Bureau of Animal Industry from the Bureau of Plant Industry at the beginning of the fiscal year. The experimental work consists essentially in the collection of supposed poisonous plants and feeding them experimentally to animals supposed to be susceptible to injury. During the past year experiments were conducted upon nine different plants. A brief synopsis follows:

Zygadenus or death camas.—A bulletin has already been published which covers the essential facts regarding this plant. Experiments have been conducted recently with a view of determining more definitely the relative toxicity of the different species, as it has been found that all are not equally poisonous.

Lupine.—The work on lupine is also considered as largely complete, so far as the general subject is concerned. However, as but little chemical work has been done upon this plant, further feeding experiments have been conducted in order to determine definitely the relative toxicity of the different species, as it has seemed very improbable that all are equally poisonous.

Aconite.—Aconite grows in great abundance in all mountain ranges in the West and is popularly supposed to be equally dangerous with the larkspur. Work in the past years has shown that in all probability cattle are seldom if ever poisoned by aconite. This work, however, is by no means completed. Feeding experiments on this plant have been carried on during the past year and some rather unexpected results have been obtained.

Senecio.—Some work on senecio was done with special reference to an unexplained disease of horses in the neighborhood of Colorado Springs, Colo. The work is not complete, but the results so far obtained seem to indicate that another cause must be sought for the horse disease.

Leucothoe davisii, or *black laurel*.—In the mountains of Colorado heavy losses of sheep have been ascribed to black laurel. A considerable number of feeding experiments were conducted with this plant and confirmed the popular belief of its dangerous poisonous character. Other laurels are also being examined.

Hymenoxys or *pingue*.—Pingue has been considered responsible for loss of sheep in southern Colorado and New Mexico for some years. Considerable experimental work has already been done upon this plant, and during the past year further experiments were conducted.

Oak.—In Utah there is a disease of cattle popularly known as "oak poisoning" or "summer sickness." It is popularly ascribed to scrub oak which grows in great abundance over certain portions of the ranges. Over other regions in the West and the Southwest it is said that there are heavy losses of cattle from oak poisoning. Somewhat elaborate feeding experiments have been conducted and certain definite results have been obtained, but the solution of the entire problem has not yet been reached.

Dugaldia hoopesii, or *sneezeweed*.—For a long time complaints have been made of the loss of sheep on the Utah range by what is popularly known as the "spewing sickness." It was at first assumed from the symptoms that in all probability the loss was occasioned by death camas, but it was deemed necessary to obtain definite proof. In the summer of 1915 a somewhat elaborate series of feeding experiments were conducted, which proved beyond doubt that the spewing sickness is caused by the sneezeweed. The symptoms and pathology of the disease have been worked out in considerable detail. A preliminary report of this work has been prepared for publication.

Eupatorium.—A study of the effect of eupatorium has been carried on in preceding years because of the supposed connection of this plant with milk sickness. This work was continued in Illinois during the fall of 1915. A series of feeding experiments were conducted on a farm where milk sickness was known to exist, and this work was supplemented by laboratory work in Washington. While the cause of the milk sickness is not yet definitely shown, the investigation has yielded certain information as to the properties of the plant in question.

BRANCH PATHOLOGICAL LABORATORIES.

The branch pathological laboratory at Chicago, besides carrying on routine work in aid of the meat inspection, has studied a condition affecting the bones of cattle, in which the marrow of the irregular bones, especially the vertebræ, ribs, and sternum, become dark red in color and soft, in some cases slightly gelatinous, resuming an embryonal character. While the lesions are suggestive of some form of infection, experimental animals (rabbits and guinea pigs) have been inoculated subcutaneously and intraperitoneally with varying amounts of a saline suspension of the marrow, with negative results.

Further work is in progress, seeking a solution of the cause of this condition.

Polyarthritis of hogs and sheep has continued to be the subject of investigation.

The work of the branch pathological laboratory at South Omaha is represented by 248 specimens sent in from various packing houses within the tributary area. There were received from a locality in Kansas specimens of calves' feces which upon microscopic examination showed that the animals were suffering with coccidial enteritis, a disease which has been very rarely reported in this country. Some other diagnoses of special scientific interest were made.

BIOCHEMIC DIVISION.

M. DORSET, *Chief.*

RESEARCH WORK ON HOG CHOLERA.

Further studies of various phases of hog cholera, relating especially to the production of serum, have been made.

A number of careful tests have demonstrated that hog-cholera serum can not be improved by certain methods that have given good results in the production of rinderpest serum in the work of an investigator (Holmes) in the service of the Government of India. That worker had been able to produce a more potent serum for rinderpest when the immune serum-producing animal was hyperimmunized within a short time following simultaneous inoculation, and he had also found that a more potent serum could be obtained when the virus used for hyperimmunization was previously diluted with a weak solution of potassium citrate. Owing to the similarity of methods of producing rinderpest and hog-cholera serums, it was thought desirable for the bureau to study the processes with respect to hog cholera. Nonimmune hogs were hyperimmunized at various times following simultaneous inoculation. The results showed that little or no protection could be expected from serum derived from hogs hyperimmunized within 10 days after simultaneous inoculation. The serum from hogs hyperimmunized between the tenth and forty-second days possessed more potency than that derived from the hogs hyperimmunized within 10 days, yet was not so satisfactory as that derived from animals held a longer time before hyperimmunization. Hogs hyperimmunized respectively 49 and 56 days after simultaneous inoculation produced good serums. Although these experiments have been negative in so far as the production of a more potent serum is concerned, they have been of much value in demonstrating, for the benefit of serum producers, that it is unwise to use hogs for serum production unless they have been inoculated simultaneously at least 60 days prior to hyperimmunization. With regard to the use of a diluted virus, it has been determined that this possesses no advantages over the undiluted virus. In fact, so far as this work has gone, the indications are that serum obtained from hogs hyperimmunized with citrated virus is not so potent as that obtained by the use of ordinary defibrinated blood.

Some experiments were carried out to test the persistence of the virus of hog cholera in the bodies of pigs following simultaneous inoculation. Eighteen pigs were given the simultaneous inoculation,

sufficient serum being employed to prevent the appearance of any clinical symptoms of hog cholera. All remained apparently well. Three were studied over an extended period. When nonimmune pigs were kept in the pen with some of them, and thus exposed merely by association, the nonimmunes in all cases remained well. Notwithstanding this fact, it was found that the virus of hog cholera was present in the circulating blood of simultaneously treated pigs for about two weeks following the inoculation. It is probable that the precise time during which the virus so persists may vary in individual cases. In order to determine the probability of this virus remaining for an indefinite period, 15 healthy nonimmune pigs were given the simultaneous inoculation in the ordinary way, and 28 days afterwards enough blood was drawn from each to inoculate 2 nonimmune pigs. All of the 30 pigs that were injected with this blood remained well. They were later exposed to hog cholera and found to be susceptible.

These experiments show why it is unnecessary, in applying the simultaneous inoculation, to graduate the dose of serum and virus in order to secure a permanent immunity. They show that although an excess of serum be used so as to prevent entirely the appearance of clinical symptoms of hog cholera, and so as to prevent the transmission of disease from one animal to another by association, yet the virus of hog cholera circulates in the blood of inoculated animals, thereby producing an active immunity. With regard to the persistence of the virus of hog cholera in simultaneously treated pigs, so far as these few experiments will permit we may conclude that (1) the virus of hog cholera persists in the blood of simultaneously treated pigs for a period of approximately two weeks following inoculation; and (2) it is probable that where sufficient serum is given to prevent the development of symptoms of disease following inoculation the virus disappears from the blood before the twenty-eighth day.

In order to determine whether larger doses of serum than any heretofore employed in experimental work would prove more effective, experiments were carried out by infecting pigs with the virus of hog cholera, and, after the appearance of clinical symptoms of hog cholera, treating them with doses of serum ranging in amount from 100 to 300 c. c. In some cases doses of 300 c. c. were administered to pigs weighing 80 pounds on the fifth day following infection. The serum had been determined by test to be of sufficient potency to protect certainly pigs of the same weight if injected in doses of 20 c. c. either immediately before or simultaneously with the virus. In none of the pigs treated with these doses of serum was there any noticeable effect upon the course of the disease. The treated pigs died as promptly as the untreated controls.

The effect of heat upon hog cholera virus was tested. The virus used consisted of defibrinated blood not phenolized. Nine experiments were carried out, the different lots of virus being heated at 50°, 55°, and 60° C. for 12, 6, and 1½ hours, respectively. In no case was the virus destroyed by the heat.

Experiments were also conducted to test the effect of heat on the potency of antihog-cholera serum. The serum used was defibrinated blood from hyperimmunized hogs. In 14 separate experiments serums were heated at 50° C. for 24 hours and 12 hours, at 55° C. for 6 hours, and at 60° C. for 1½ hours and ½ hour. It was found

that defibrinated blood serum can not be heated with safety at a temperature greatly in excess of 50° C. Above 55° C. there is a tendency to coagulate, and at 60° C. the defibrinated blood becomes a semisolid mass. When the defibrinated blood was coagulated by the heat the fluid portion was separated from the clot by pressure and sufficient serum thus obtained to inject pigs. It was found that all of the heated serums retained their potency. It thus appears from these experiments (1) that hog-cholera serum in the form of defibrinated blood can not, with safety, be heated at 60° C., although the antitoxin is not destroyed even by 1½ hours' heating at that temperature; and (2) that the antibodies of the serum will withstand heating at 50° C. for 24 hours.

One experiment was carried out to test the effect of drying on hog-cholera serum by subjecting the serum to freezing and drying in vacuo according to the method originally developed by Harris for the preparation of antirabic vaccine and later applied by Rogers to the drying of cultures of *Bacillus bulgaricus*. Test of the serum thus prepared showed that the antitoxic properties of the serum were not impaired by drying, and that pigs treated with the dried material which was taken up in water before injection were completely protected against hog cholera.

Certain cases of foot-and-mouth disease occurring in the course of the outbreak of 1914-1916 were found to have been due to the use of hog-cholera serum that was contaminated with the virus of the former disease. This led to experiments with a view to developing a process that would safeguard hog-cholera serum against the infection of foot-and-mouth disease in case that infection should by accident occur in the blood of the serum-producing hogs. Tests on animals on a scale that would be commercially practicable can not be relied upon to eliminate the possibility of such infection; none of the ordinary antiseptics suitable for the preservation of serum can be relied upon to destroy the virus of foot-and-mouth disease; and no practicable process of filtration would be sufficient to remove the virus, since it can pass through laboratory filters. It therefore appears that only by the application of heat, to which the virus of foot-and-mouth disease is comparatively sensitive, and which, within limits sufficient to destroy the virus, does not destroy the potency of the serum, is it possible to accomplish the desired object. As the serum in the form of defibrinated blood can not be heated safely much above 50° C., owing to the fact that the blood undergoes coagulation, it was also desirable to eliminate the red blood cells so that the proper degree of heat for rapid sterilization might be applied. Efforts were therefore made to devise a means of separating the red blood cells from the serum in a simple and yet effective manner. After experimentation it was found that this could be accomplished by adding to the defibrinated blood a minute quantity of extract of the common garden bean. A successful and practicable process has thus been worked out, by which the red cells are agglutinated by the bean extract and the resulting clear serum is sterilized against foot-and-mouth disease by heating for 30 minutes at 59° or 60° C. The experiments and the process are described in detail in a paper in the *Journal of Agricultural Research*.¹ Preliminary work for the com-

¹"A method for producing clear and sterilized antihog-cholera serum." By M. Dorset and R. R. Henley. *Journal of Agricultural Research*, vol. 6, p. 333.

mercial application of this method has already been begun by certain establishments.

ENFORCEMENT OF THE VIRUS-SERUM-TOXIN ACT.

In the work under the virus-serum-toxin law of 1913 the Biochemic Division exercises supervision over the preparation of antihog-cholera serum, hog-cholera virus, tuberculin, and mallein, while other biological products are supervised by the Pathological Division. The work of the latter division has already been stated, but for convenience the entire work will be summarized here.

One hundred and nine applications for licenses for the manufacture of such products for interstate trade were received, and 106 licenses were issued. Permits for importation were issued to two firms. The licensed plants were situated in 50 cities in 18 States. Two hearings were held as provided by law. Five cases of apparent violation of the law were investigated, and two such cases were successfully prosecuted through information furnished to the Department Solicitor.

Eighty-nine of the licensed plants were licensed to manufacture antihog-cholera serum. During the calendar year 1915 there was prepared by licensed establishments 208,571,232 cubic centimeters of this serum, of which 4,471,881 cubic centimeters was found to be worthless or contaminated and was withheld from market.

DISTRIBUTION OF TUBERCULIN AND MALLEIN.

During the fiscal year 643,622 doses of tuberculin were sent out to State, county, and city officials, to be used in testing cattle for tuberculosis. Mallein to the extent of 269,280 doses, for testing horses and mules for glanders, was likewise supplied. The production of mallein for the subcutaneous test has been discontinued and there is now supplied from the laboratory only the mallein intended for the ophthalmic test.

DIPS AND DISINFECTANTS.

The laboratory of dips and disinfectants received for examination 240 samples of live-stock dips, disinfectants, and miscellaneous materials employed in the preparation of dips and disinfectants.

During the calendar year 1915 there were sent out the following test outfits and supplies for making tests of dips in the field: Two hundred and fifty-eight test outfits for arsenic; supplies for making more than 99,000 arsenical tests; 73 test outfits for lime-sulphur dips; supplies for about 12,400 lime-sulphur tests; supplies for nearly 7,500 nicotin tests.

Further work has been done upon the disinfection of hides. It was stated in the last annual report that the Schattenfroh method was found to be very efficient in destroying anthrax spores. Later observations of the use of this method for the practical disinfection of hides at tanneries have indicated that it is unsatisfactory because of the discoloration and consequent injury to the value of the hides. In view of these practical observations, additional work has been begun with ordinary solutions of bichlorid of mercury. These experiments are not yet completed.

Additional work was completed on new methods for the analysis of lime-sulphur solutions, resulting in the publication of a second technical paper on the subject. The final objective of these methods of analysis, namely, a study of the reactions and combinations which occur in the preparation and use of lime-sulphur solutions, has also been followed up and the results prepared for publication. We now have more definite knowledge of just what compounds are present in such solutions and of the proportions of ingredients which should be used in their manufacture.

A satisfactory formula for a "saponified cresol solution," to replace the "compound solution of cresol, U. S. P.," which can now be obtained only with difficulty and at great expense, has been worked out, and the formula has been adopted by the bureau and the use of the new product permitted in the disinfection of stock pens, cars, etc., under the bureau's regulations. The new product differs from the United States Pharmacopœia preparation in that a cheaper grade of cresol is employed, caustic soda replaces caustic potash, and the proportion of linseed oil is reduced.

COOPERATION WITH INSECTICIDE AND FUNGICIDE BOARD.

The bureau has continued its collaboration with the Insecticide and Fungicide Board through the examination of samples of insecticides and fungicides intended for use in combating diseases of animals. The Assistant Chief of the Biochemic Division continues as a member of the board and gives much of his time to its work. During the year samples representing 166 cases were examined, and in 111 instances misbranding or adulteration was found. Laboratory analyses indicate that the composition of insecticides of this class is being varied considerably, thus indicating an effort on the part of manufacturers to introduce new substances of supposed value. The introduction of new and hitherto little used substances has necessitated an unusual amount of laboratory work, including some research work.

STUDIES OF CHANGES IN MEATS DURING COLD STORAGE.

Investigations concerning changes in meats during cold storage, as outlined in last year's report, have been continued, and some of the studies have been completed.

In studies of the changes taking place in fresh beef during cold storage at temperatures above freezing, beef was held at 32° to 38° F. for periods ranging from 14 to 177 days. From a chemical standpoint the changes taking place in the muscular tissue of the beef under these conditions were found to consist chiefly in an increase in acidity and increases in proteose nitrogen, noncoagulable nitrogen, and ammoniacal nitrogen, as well as in soluble inorganic phosphorus. There was a decrease in coagulable nitrogen and in soluble organic phosphorus. In so far as the muscular tissue of the beef is concerned, it appears that storage under the conditions of these experiments was without effect upon either the nutritive value or the wholesomeness of the meat. In the case of the kidney fat and of external fatty tissues, after the longer periods of storage there was

a marked increase in acidity, accompanied by a certain degree of rancidity, sufficient, in some cases, to render the fat unsuitable for food. The principal effect of storage upon the organoleptic properties of beef consisted in a marked increase in the tenderness of the meat. This change took place in from 14 to 28 days, but did not appear to progress appreciably during continued storage. The bacteria and molds which grew on the surfaces of the meat in storage did not penetrate the muscular tissue to any great depth, and no change in the histological structure of the muscle fiber was noticeable after 177 days of storage. It appears that the increased tenderness of the meat in storage can not be attributed to bacterial action, but probably results from the action of enzymes normally present in the muscular tissue.

Although it was found to be possible to hold meat for 177 days in a small cold-storage room used for experimental purposes, similar pieces of meat could not be held in storage at the same temperature in the cooler of a modern packing house for longer than 55 days. The difference in the keeping quality of the meat in the two coolers is to be attributed to the much greater humidity of the packing-house cooler. The length of time that fresh beef can be preserved in a wholesome condition in cold storage at temperatures above freezing is dependent upon a number of factors, chief among which are the temperature and humidity of the storage room and the condition of the beef when placed in storage. A paper describing these experiments, prepared by Ralph Hoagland, C. N. McBryde, and W. C. Powick, has been submitted for publication.

In connection with the cold-storage experiments, certain portions of sterile muscular tissue of beef were held under aseptic conditions at 98.6° F. for various periods of time. It was found that under these conditions there was a marked transformation of the muscle creatin into creatinin. This change is ascribed to the action of enzymes occurring normally in the muscular tissue, and the findings throw interesting light upon a certain phase of tissue metabolism. The results of this work have been published in the *Journal of Agricultural Research*.¹

In subsidiary investigations carried along during the regular cold-storage studies it was found that when ox muscle, obtained under aseptic conditions, is incubated at 98.6° F. for various periods of time, the natural coloring matter of the meat, oxyhemoglobin, is transformed into hematoporphyrin. These observations are of much importance because of their possible significance concerning the formation of bile pigments in the body. It appears not improbable that hematoporphyrin is an intermediate product in the form of bile pigments, the hematoporphyrin being formed in the muscular tissue and later changed into bile pigments by the liver. A report of this work has been published in the *Journal of Agricultural Research*.²

Besides the above-described research work, there has been developed during the year a satisfactory method for the determination of sugar in meats. A detailed report of this work will be submitted

¹ "Effect of autolysis upon muscle creatin." By Ralph Hoagland and C. N. McBryde. *Journal of Agricultural Research*, vol. 6, p. 535.

² "Formation of hematoporphyrin in ox muscle during autolysis." By Ralph Hoagland. *Journal of Agricultural Research*, vol. 7, p. 41.

later. A careful study has also been made of the method for determining nitrates in meats. The conventional methods were found unsuitable for work which requires a high degree of accuracy. Preliminary work with the nitron method has given promising results.

ZOOLOGICAL DIVISION.

B. H. RANSOM, *Chief.*

ROUNDWORMS OF SHEEP.

At the bureau farm (leased) near Vienna, Va., approximately 100 ewes and lambs were used in the experiments of 1915 with reference to parasitic roundworms. These animals were separated into four lots. Lot A (ewes and lambs) was kept continuously on the same pasture from May to September. Lot B (ewes and lambs) was kept on a double pasture from May to September, grazing alternately two weeks in each of the two parts. The ewes and the lambs of Lot C were kept separate except at noontime and at night, when they were allowed together in a barn with slat floors, which were frequently cleaned and disinfected (at least once a week). During the day the lambs were allowed to graze on temporary pastures, and it was planned to move them once a week to fresh ground, but owing to certain circumstances this plan was not followed strictly. During the latter part of the summer they were moved week by week over the same areas grazed during the early summer, a new crop meanwhile having been planted and grown. Lot D (ewes and lambs) from May to September were moved once a week to fresh pasture, and were kept together most of the time, the ewes occasionally being separated from the lambs and grazed on infested pasture when the available fresh pasture was limited.

Lambs from each of the lots were killed and examined in September or later, at least five from each lot being examined. Those which died at any time during the progress of the experiments also were examined. Eleven were examined from Lot A, 18 from Lot B, 5 from Lot C, and 12 from Lot D.

No material difference was observed in the degree of stomach-worm infestation in the various lots, but it is noteworthy that a great reduction in the number of stomach worms present occurred in all of the lots after the first of November, as a rule only a comparatively few individual worms being found instead of the usual thousands found in the lambs or ewes examined earlier. There were no important differences between Lot A (continuously on one pasture) and Lot B (two weeks alternately in each of two pastures) with reference to hookworms, nodular worms, lungworms, and tapeworms. The lambs of Lot C (grazed separately from their mothers and moved every week to fresh ground or ground not recently grazed) showed hookworms in only one case and then only two specimens; they had few or in some cases no nodular worms or worm nodules, no tapeworms, and no lungworms. The lambs of Lot D (grazed with their mothers on fresh pasture every week) also had comparatively few hookworms, nodular worms, and worm nodules (but more than in Lot C). Only one had lungworms and none tapeworms.

These experiments apparently indicate that the plans followed as to change of pastures can not be depended upon to control parasitic

infestation in lambs, especially in the case of the stomach worm, although on the other hand it appeared that a change of pasture every week during the season from May 1 to September 1 kept down the infestation of lambs with hookworms, nodular worms, lungworms, and tapeworms to a very small amount. Seemingly, therefore, these parasites can be more easily controlled than the stomach worm by a system of pasture rotation.

That the number of stomach worms present in a given animal becomes, under some circumstances at least, greatly diminished during the winter, is an interesting point brought out in the investigations; and if this proves to be the rule, and if the controlling circumstances can be determined, a fact of no small practical importance will have been established. The probable meaning of the presence of only a few stomach worms in sheep during the winter following a summer in which they were comparatively numerous in other sheep of the same flock is that the average length of life of the adult stomach worm is not more than a few weeks or months; in brief, that the stomach worm is essentially a short-lived parasite.

In the series of experiments following the foregoing and now in progress, medicinal treatment is being combined with the periodical changing of pastures, inasmuch as it appears that methods based upon the changing of pastures alone are not likely to prove satisfactory in the control of the internal parasites of sheep, particularly in the case of the stomach worm.

TREATMENT AND CONTROL OF EXTERNAL PARASITES.

Sheep ticks.—A series of experiments on the treatment of sheep to destroy ticks, extending over about two years, has been completed, and a Farmers' Bulletin on the subject is in course of preparation. Further experiments to check the findings of earlier work are still in progress. Plans are being made for a series of experiments on a very large scale in Wyoming.

Sheep scab.—A series of experiments which has been in progress about one year is nearing completion. These have to do with the vitality of the scab mite, the curative and protective action of various dips, the value of sulphur as a scab remedy, and various other phases of the sheep-scab problem.

Spinose ear ticks of cattle.—Experiments in the treatment of cattle to destroy ear ticks have been carried on in New Mexico, California, and Texas. Various substances have been tried as remedies, including castor oil and nicotin, arsenical solutions, tar oils, carbolic acid, and pine tar, using various methods of application. Varying success has been obtained, but no fully satisfactory remedy has been discovered.

Cattle lice.—Experiments in treatment for cattle lice have been carried on in Colorado, Nebraska, and New Mexico. From the data now at hand it appears, so far as concerns the biting louse and the long-nosed sucking louse, that the lime-sulphur-arsenic dip and the Bureau of Animal Industry arsenical solution will free cattle from lice in a single dipping, whereas coal-tar creosote dips, nicotin-and-sulphur dips, and nicotin dips require two dippings, with an interval of about two weeks between dippings. Lime-sulphur dip is not effi-

cacious against lice. A period of 20 days is probably amply sufficient to free premises of cattle lice if cattle are excluded. The experiments are incomplete with reference to the short-nosed cattle louse, so that the conclusions stated above do not necessarily apply to this species, which may prove to be more difficult to eradicate. Certain observations were made indicating that it is more resistant than the other two species.

Ox warbles.—Experiments in the treatment of cattle to eradicate warbles are in progress in Utah, Colorado, and New Mexico, but results will not be reached until next year.

Miscellaneous.—Experiments in treatment for lice of sheep, goats, and hogs and for sarcoptic mange of cattle and hogs are in progress in Colorado, Utah, California, and elsewhere, but no definite results have yet been obtained.

In cooperation with the Insecticide and Fungicide Board, tests of various proprietary remedies for the destruction of external parasites of live stock have been carried out or are still in progress.

ANTHELMINTICS AND TREATMENT FOR INTERNAL PARASITES.

Experiments recently carried out indicate that anthelmintics are commonly less effective than they are generally supposed to be. Certain remedies most used by physicians and veterinarians for the removal of parasitic worms, when administered in the customary doses, have been found to be less effective than other substances not in common use as anthelmintics. Some of the latter have given very favorable results under experimental conditions, and promise to prove more satisfactory for practical use than those now employed.

Various proprietary articles sold as insecticides or fungicides and for which anthelmintic properties are also claimed by the manufacturers have been tested in response to requests from the Insecticide and Fungicide Board.

INVESTIGATIONS OF PARASITIC PROTOZOA.

In continuing studies of the life history of Sarcosporidia further facts have been determined which throw a new light upon the question of the systematic relationships of these parasites. Of greater practical interest is the confirmation of Negri's work, generally overlooked or disregarded, by which it has been shown that sarcosporidiosis may be transmitted to healthy animals by feeding them the feces of affected animals in certain stages of the disease. The feces are still infectious after drying. It seems quite probable that the ingestion of feces from diseased animals, or of food or water contaminated with infectious fecal material, is the usual mode of infection with sarcosporidiosis in the case of herbivorous animals, which obviously do not acquire their infection in the way the disease is commonly transmitted in the laboratory, namely, by the feeding of muscle containing the parasites.

Investigations have been begun of the disease of turkeys known as blackhead or infectious entero-hepatitis, as to the causative agent of which several opinions have been expressed. So far as the investigations have gone it appears quite certain that the disease is not a coccidiosis, but positive conclusions as to the nature of the causal organism have not yet been reached.

COLLECTION OF PARASITES.

During the year 475 specimens were added to the collection of parasites maintained by the bureau for study and reference. One of the most interesting specimens received was a piece of horse muscle infested with a larval tapeworm resembling the intermediate stage of *Tænia solium*. A similar parasite has not heretofore been recorded from the horse.

ZOOLOGICAL INVESTIGATIONS RELATING TO MEAT INSPECTION.

Investigations on the effects of curing upon the vitality of trichinæ have been continued. As an alternative to refrigeration for 20 days at 5° F., certain curing processes have been permitted in establishments under Federal meat inspection in the preparation of hams and sausages of kinds customarily eaten without cooking. These methods are being subjected to repeated tests supplementing those originally made, in order that the methods finally adopted may be established on the firmest possible basis as to their adequacy in destroying the vitality of trichinæ. During the year about 150 tests of this kind were made. As a result of these tests it has been found necessary to discontinue one of the curing processes for hams because it was found that this process did not invariably destroy the vitality of trichinæ.

MISCELLANEOUS INVESTIGATIONS OF ANIMAL PARASITES.

Further investigations of the life histories of tapeworms of sheep and other herbivorous animals have failed to show how these parasites are transmitted.

The gapeworm of turkeys, generally considered to be of the same species as the form occurring in chickens, although usually considerably larger, has been definitely shown to be transmissible to chickens. Young chickens begin to show symptoms of gapes in about a week after feeding with cultures containing the embryos of the parasite. Full-grown turkeys harboring gapeworms show no recognizable symptoms. Infested turkeys are probably in many cases an important source from which chickens become infected with gapeworm disease. Young stages of the gapeworm have been found in various organs following the feeding of cultures to experimental chickens, and a number of gaps in our knowledge of the way in which the parasite reaches its location in the air passages have been filled up. The evidence thus far obtained tends to show that the young worms do not migrate, after hatching in the alimentary tract, up the esophagus and down into the trachea, as supposed by some investigators, but that they are probably distributed by the circulation or by direct migration through the body cavity and into the lungs.

Among various miscellaneous investigations may be mentioned studies of certain species of flukes, roundworms of horses, resistance of the eggs of tapeworms to different chemicals, parasites of live stock in the island of Guam, and certain phenomena in the biological relations between parasites and their hosts.

Sixty-five imported sheep dogs were examined in quarantine for the presence of tapeworms transmissible to live stock, and 9 were found to be infested and were subjected to anthelmintic treatment before they were released.

MISCELLANEOUS DIVISION.

A. M. FARRINGTON, *Chief*.

The Miscellaneous Division has continued its work of keeping records and conducting correspondence regarding civil-service examinations for positions in the bureau, appointments to such positions, promotions, demotions, transfers, removals, the conduct of employees as to efficiency, the acceptance of outside employment, and other matters relating to the general subject of personnel; also the keeping of records pertaining to the various projects of the bureau, the carrying on of correspondence relative to the supervision which the bureau maintains over veterinary educational institutions under department regulations, and the handling of miscellaneous correspondence and other matters which do not come within the scope of the work performed by other divisions.

BUREAU PERSONNEL.

At the beginning of the fiscal year the persons in the employ of the bureau numbered 4,106. During the year there were 601 additions, made up as follows: Appointments, 547; transfers from other branches of the Government service, 35; reinstatements, 19. During the same period there were 694 separations from the service, divided as follows: Resignations, 226; deaths, 35; transfers to other bureaus or departments of the Government, 24; other separations without delinquency, including temporary appointments, 394; removals for cause, 15. June 30, 1916, the bureau personnel numbered 4,013, a net decrease of 93 from the number a year before.

Now that foot-and-mouth disease has been eradicated, all the employees assigned to that work have been returned to their former duties. As a considerable number of extra appointments were necessary to replace men transferred from their regular duties to the foot-and-mouth disease eradication work, the return of these men to their regular duties made necessary some readjustments. The extra men were assigned to the various stations to replace men separated from the service by death, resignation, or other causes. This accounts for the slight decrease in the number of employees in the service June 30, 1916, as compared with the number on the rolls on the corresponding date of the previous year.

During the year four civil-service examinations were requested, and subjects and weights were furnished to the Civil Service Commission.

VETERINARY EDUCATION.

Two important forward steps in veterinary education have been taken in the past year. One is the raising of the entrance requirements of colleges, and the other is an addition of one year to the course of study.

In the regulations which govern entrance to the civil-service examination for veterinary inspector in this bureau, which were promulgated some years ago, there is a regulation which specifies the kind

of entrance examination which shall be conducted by accredited veterinary colleges before a student can be admitted. It was deemed advisable to increase the standard of elementary instruction, and by order of the Civil Service Commission and concurrence of the Secretary of Agriculture the entrance examination was raised. To enter an accredited veterinary college the applicant having a diploma from a high school or a recognized college or normal school or a first-grade teacher's certificate may enter without examination; but if he is not provided with either of these papers an examination is required. This examination is now the first-grade civil-service examination instead of the second grade as formerly.

Under the regulations accredited veterinary colleges in the past have maintained a course of three years, but there has been a growing sentiment to the effect that this time is too short to obtain adequate instruction in the complicated and many-sided study of veterinary medicine. The majority of the veterinary colleges, through their own initiative and by agreement, have established voluntarily a course of four years, to begin with the session commencing in September, 1916. This movement to encourage higher veterinary education has been indorsed by the Civil Service Commission and the Secretary of Agriculture, and will go into effect in September, 1917, for all accredited veterinary colleges.

During the year there has been no veterinary college added to the accredited list and none removed. The number is the same as last year—namely, 21 American and 8 foreign colleges.

When it became generally known that the veterinary colleges were to increase the length of the course, many students who were contemplating the study of veterinary medicine took up the course, in order to take advantage of graduation after three years instead of four years, and there was an enrollment of nearly 3,000 students for the session 1915-16, or an increase of 442 over the preceding session. Of these 734 completed the course, and were graduated at the end of the session, or 36 more than were graduated from the previous session.

EXPERIMENT STATION.

E. C. SCHROEDER, *Superintendent.*

The work of the experiment station, as heretofore, has comprised tests, studies, and investigations, made both independently and in cooperation with other divisions, concerning infectious diseases of domestic animals, and the provision of facilities required by the other divisions to make studies on large animals under normal or farm conditions. The subjects which have received the most attention during the year are infectious abortion and tuberculosis.

INFECTIOUS ABORTION OF CATTLE.

While we are still in the dark as to many of the factors on which the persistence and the dissemination of infectious abortion of cattle depend, much has been learned from a study of this disease. Probably the simplest, clearest, and briefest way to define what the station has done and is doing with this disease is to enumerate some of

the principal facts that it has either discovered or proved to be true, as follows:

1. That infected cows often remain carriers of the bacillus of infectious abortion disease long after they have ceased to manifest symptoms of their infected condition.

2. That cows which have never aborted and regularly produce seemingly normal calves may be chronic carriers and disseminators of abortion bacilli.

3. That the habitat of the abortion bacillus in the bodies of infected cows that are apparently healthy is the udder.

4. That the infection in an infected udder may be limited to a single quarter, or may exist in two, three, or all quarters.

5. That both the milk and the blood serum of cows with infected udders invariably agglutinate suspensions of abortion bacilli.

6. That colostrum from cows with infected udders has enormously high agglutinating potency for abortion bacilli.

7. That the agglutinating potency of the blood serum of a pregnant cow is not a reliable measure of the probability of an abortion or a normal parturition.

8. That careful tests made with blood, the hearts, livers, kidneys, lungs, spleens, lymph glands from all portions of the body, nerve and brain tissues, muscles, uterus, ovaries, etc., from cows infected with abortion bacilli have failed to reveal the presence of the bacilli elsewhere than in the udder, supramammary lymph glands, rarely in some of the lymph glands of the pelvis, and in the uterus only near the time of an abortion or at parturition.

9. That the abortion bacillus is an organism which is amazingly resistant to natural germ-destroying agencies.

The best known means of guarding against the ravages of this serious disease is the proper use of the agglutination test, which is very reliable and not expensive. The test should be applied to every new animal purchased before it is permitted to come into contact with the uninfected herd. The chronic carriers of abortion bacilli, which we have proved to be numerous, must be regarded for the time being as the greatest menace against which the herd should be protected so far as this disease is concerned, and the agglutination test has a high potency in detecting such chronic disseminators.

TUBERCULOSIS.

Most of the work on tuberculosis has been a continuation of the investigations and studies which have been in progress for a number of years. The small cost in money and labor with which several tuberculous and several nontuberculous groups of animals have been kept at the station year after year without the transmission of the disease in a single instance from the former to the latter, throws an encouraging light on the practicability of eradicating this disease.

The persistence of tubercle bacilli in the bodies of rats and mice, in a seemingly dormant state so far as the production of disease is concerned, has received further attention. Rats as well as mice, after being permitted to eat tuberculous animal tissues one day only, may continue to carry in their bodies tubercle bacilli, which cause no disease referable to them, for more than a year. Tests are being

made to determine whether hogs can contract tuberculosis through eating such infected rats and mice.

MISCELLANEOUS WORK.

Various miscellaneous tasks and investigations were carried out during the year, such as testing suspected material for foot-and-mouth disease, testing the potency of commercial tuberculin, studying the relative food value and digestibility of raw, pasteurized, and boiled milk for unweaned animals, providing sera and other materials for the bureau's Washington laboratories, etc.

The usual farm operations were conducted and a large number of small experiment animals raised.

EXPERIMENTS AND DEMONSTRATIONS IN LIVE-STOCK PRODUCTION IN CANE-SUGAR AND COTTON DISTRICTS.

The experiments and demonstrations in live-stock production in the cane-sugar and cotton districts of the United States have been continued under the direction of the committee consisting of William A. Taylor, Chief of the Bureau of Plant Industry, chairman; B. H. Rawl, Chief of the Dairy Division, Bureau of Animal Industry, and W. R. Dodson, director, Louisiana experiment station, and director of extension service, Louisiana State University.

Of the \$60,000 appropriated by Congress for this work, \$39,300 was allotted for buildings, equipment, live stock, and the maintenance of the farm at New Iberia, La., and \$20,700 was devoted to the extension and demonstration work.

The farm of 500 acres deeded by the State of Louisiana to the Department of Agriculture is operated in four units, one devoted to horses and mules, one to beef cattle, one to hogs, and one to dairy cattle and hogs combined. This work is in charge of Dr. C. E. Mauldin.

Further progress has been made in the erection of buildings, which include an office building, 3 cottages for employees, 6 houses for laborers, 3 barns, 8 silos, a tool shed, a jack shed, a hog-feed house, 13 hog cots, and a pump house. A pneumatic water plant has also been installed, which supplies water to all pastures, lots, and buildings.

Live-stock purchases include a breeding jack, a Hereford bull, a Jersey bull, a Duroc-Jersey boar, and 75 head of feeder steers. The live stock has been further added to by natural increase.

The first year's experiment, comparing the relative merits of mules and brood mares as work animals for southern sugar-cane farm conditions, was carried on with six high-grade "sugar mules" and nine grade mares showing Percheron, Shire, Belgian, and roadster breeding. The mules consumed less feed and performed more days of work at less cost, but considering the foals dropped, the mares were found to earn \$32.19 each more than the mules. If the raising of work stock can be introduced successfully into the South, it will mean the saving of several million dollars annually which is now paid to outside markets for mules.

An experiment has been begun to determine the cost of maintaining a beef-producing herd and to test the relative profit from spring

and fall calves, as well as to determine the cost of producing a breeding heifer and a feeding steer, also to make other studies in the management of a beef herd. Forty cows are used in this experiment and are being bred to the Hereford bull.

The first steer-feeding trial to determine the most economical silage to use with cottonseed meal and the value of cane tops for silage has been completed. Corn and soy-bean silage produced the most rapid and the cheapest gains, with the other silages following in the order named: Corn and sorghum, corn, sorghum, cowpeas and soy beans, corn and cane tops.

Experiments in hog grazing have been begun with 67 shoats, and plans are being made to establish a dairy herd.

The live-stock extension work continues under the supervision of Prof. W. R. Dodson, with Dr. G. E. Nesom in direct charge of the work. At the close of the fiscal year 23 beef-cattle demonstrations were being conducted in 14 parishes, 45 hog demonstrations in 17 parishes, and 17 poultry demonstrations in 11 parishes, representing all sections of the State.

The forage-crop agent, working with the live-stock agents, has instructed the cattle and hog demonstrators as to pasture grasses, grazing crops, and rotations best suited to respective conditions. As a result more animals are kept on a given area at less expense and in better condition. There is evidence of greater prosperity with all the farmers who are making live stock a part of their diversified farming.

The production of beef cattle has been advocated for the purpose of utilizing waste pasture land and surplus feeds. Native cattle are being improved by the use of pure-bred beef bulls. The selection of sires and breeding cows is receiving more attention. About 2,000 head of pure-bred and high-grade cattle for breeding purposes have been introduced into the State. Two breeders' associations have been organized, and assistance was rendered in conducting beef-cattle sales at the State fair.

The object of the hog demonstrations is to improve the quality and increase the number of hogs produced profitably in Louisiana. All the 48 herds are headed by pure-bred boars, and 75 per cent of the sows are pure-bred.

Two men have devoted their time to dairy extension work, which has been conducted with the small, needy farmer with limited means, and also with the large planter. Assistance has been given in building 24 silos and in the construction and remodeling of a number of dairy buildings. Dairy farmers have purchased 51 pure-bred bulls, 180 pure-bred females, and 218 grade females. Assistance has been given toward improving the milk supply of New Orleans by work with milk-distributing plants and with the individual dairy farmers.

The committee has joined with the Office of Markets and Rural Organization of this department and the extension service of the Louisiana State University in a study of market conditions and the collection and distribution of information on that subject. The local curing of pork is encouraged. Three cooperative shipping associations have been organized, and two more are in process of organization.

An important aid to the demonstrators in getting breeding stock and in disposing of surplus stock has been the establishment of a live-stock exchange in the office of the live-stock extension service.

Since these experiments and demonstrations were begun there has been a very noticeable improvement in live stock in Louisiana, as evidenced by the more extensive use of mares for farm work and breeding purposes, a rapid increase in the number and quality of both beef and dairy cattle, growth in the hog industry, a better appreciation of pure-bred poultry as a side line, and a general revival of the sheep industry, especially in the cut-over pine lands in some of the parishes and in the southwest corner of the State.

REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., October 13, 1916.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1916.

Respectfully,

WM. A. TAYLOR,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

The Bureau of Plant Industry includes in its field a wide range of activities having to do with the solution of plant problems. These have chiefly to do with crop production and utilization, including the improvement of plants by breeding and cultural methods, the investigation and development of methods of control of destructive diseases of plants, the introduction and acclimatization of crops from other parts of the world, the determination of crop relationships, both agronomic and economic, and the meeting of agricultural emergencies as they arise from time to time in widely separated regions of the country.

Effectively to cope with problems so diverse in character and location, a flexible form of organization has been developed, which is capable of prompt readjustment to meet the changing requirements of the work. The organization during the year has been as follows:

Laboratory of Plant Pathology.....Erwin F. Smith, Pathologist in Charge.
Pathological Collections.....Flora W. Patterson, Mycologist in Charge.
Fruit-Disease Investigations.....M. B. Waite, Pathologist in Charge.
Investigations in Forest Pathology.....Haven Metcalf, Pathologist in Charge.
Citrus-Canker Eradication.....Directed by Karl F. Kellerman, Assistant
Chief of Bureau.

Cotton and Truck Disease Investigations.....W. A. Orton, Pathologist in Charge.

Crop Physiology and Breeding Investigations.....W. T. Swingle, Physiologist in Charge.

Soil-Bacteriology and Plant-Nutrition Investigations.....Directed by Karl F. Kellerman, Assistant
Chief of Bureau.

Soil-Fertility Investigations.....Oswald Schreiner, Biochemist in Charge.

Acclimatization and Adaptation of Crop Plants: Cotton Breeding.....O. F. Cook, Bionomist in Charge.

Drug-Plant and Poisonous-Plant Investigations.....W. W. Stockberger, Physiologist in Charge.

Physiological and Fermentation

Investigations	R. H. True, Physiologist in Charge.
Agricultural Technology	N. A. Cobb, Technologist in Charge.
Fiber-Plant Investigations	L. H. Dewey, Botanist in Charge.
Grain Standardization	J. W. T. Duvel, Technologist in Charge.
Biophysical Investigations	Lyman J. Briggs, Biophysicist in Charge.
Seed-Testing Laboratories; Enforcement of Seed Importation Act	E. Brown, Botanist in Charge.
Cereal Investigations	M. A. Carleton, Cerealist in Charge.
Corn Investigations	C. P. Hartley, Physiologist in Charge.
Tobacco Investigations	W. W. Garner, Physiologist in Charge.
Paper-Plant Investigations	Directed by C. J. Brand, Chief of Office of Markets and Rural Organization.
Alkali and Drought Resistant Plant Investigations	T. H. Kearney, Physiologist in Charge.
Sugar-Beet Investigations	C. O. Townsend, Pathologist in Charge.
Economic and Systematic Botany	Frederick V. Coville, Botanist in Charge.
Dry-Land Agriculture Investigations	E. C. Chilcott, Agriculturist in Charge.
Western Irrigation Agriculture	C. S. Scofield, Agriculturist in Charge.
Horticultural and Pomological Investigations	L. C. Corbett, Horticulturist in Charge.
Arlington Experimental Farm	E. C. Butterfield, Assistant Horticulturist in Charge.
Gardens and Grounds	E. M. Byrnes, Assistant in Charge.
Foreign Seed and Plant Introduction	David Fairchild, Agricultural Explorer in Charge.
Forage-Crop Investigations	C. V. Piper, Agrostologist in Charge.
Congressional Seed Distribution	R. A. Oakley, Agronomist in Charge.
Demonstrations on Reclamation Projects	F. D. Farrell, Agriculturist in Charge.

From September 1, 1915, to August 31, 1916, the changes in the personnel of the bureau were as follows: Resignations, 304; deaths, 7; removals, 3; transfers from bureau, 48; furloughs, 85; terminations of appointments, 446; making a total of 893 employees dropped from the rolls during that period. There have been made in the same period 1,729 appointments, increasing the total force of the bureau by 836. On September 1, 1916, the numerical strength of the bureau was as follows: In Washington, 861; outside of Washington, 1,419; of which 634 were engaged in the cooperative work on the eradication and control of citrus canker and 61 in the cooperative work on the eradication and control of white-pine blister rust; total, 2,280. The total number of employees in the bureau on the same date a year ago was 1,444.

The activities of the bureau during the past year are outlined more or less fully in the 36 papers in the *Journal of Agricultural Research*, 40 *Department Bulletins*, 20 *Farmers' Bulletins*, and 34 circulars, which have been included in departmental publications as contributions from this bureau. Certain of the more striking results of the investigational work, however, that have become evident during the year are here summarized.

PLANT PATHOLOGICAL INVESTIGATIONS.

CITRUS-CANKER ERADICATION.—Cooperative arrangements have been made with State officials of Florida, Texas, Louisiana, Mississippi, Alabama, Georgia, and South Carolina to insure the thorough inspection of nurseries and citrus groves for the purpose of promptly and completely eradicating citrus canker. In outlining plans for the

eradication of citrus canker emphasis has been placed upon the magnitude of the undertaking because of the extreme infectiousness of the disease and the wide area throughout which it has been disseminated. As has been pointed out in earlier discussions of this work, no final statement regarding the complete eradication of the disease can be expected within a period of at least two years. It appears, however, that the campaign is progressing very satisfactorily in the commercially important orange and grapefruit regions of Florida. Supplemental protective measures, such as formalin treatments of infected soil and the protective spraying of groves exposed to infection, are materially hastening the work of eradication through the destruction of diseased trees and decreasing the number of secondary outbreaks. Even in the few places where citrus canker outbreaks have occurred in commercial districts and in old trees, it appears possible to eradicate the disease promptly and effectively. Although thorough inspection of citrus plantings will be necessary throughout at least the coming fiscal year, it is believed that Florida is now practically free from the disease. In Texas, Louisiana, Alabama, and Mississippi the work has been somewhat more difficult from the beginning, because of the more scattered character of the plantings and the smaller interest in the matter due to the comparatively low commercial value of the citrus plantings as compared with other agricultural developments of those States. Furthermore, in all of these States the unusually severe tropical storms of the present year have caused an unexpectedly wide distribution of citrus canker in some areas, practically entire counties having been infected. Even in these States, however, the progress of the work appears to be encouraging, and if no further unusual drawbacks are encountered the disease will be effectively checked. South Carolina, Georgia, Alabama, and Mississippi should have but a very small percentage of infected trees at the close of the present fiscal year. The eradication of the disease from Louisiana and Texas will apparently be more difficult and will almost certainly require a greater length of time. Material reduction in the quantity of infection has been effected in Louisiana, but in some areas the disease has been so widespread that it is as yet problematical whether its occurrence in adjacent territory can be prevented. In Texas the ornamental plantings of citrus, especially in hedges, extend over such a wide area that the difficulties both of inspection and of effective eradication are extreme.

POTATO DISEASES.—Experiments leading to a determination of the factors necessary for the production of disease-free potatoes in western irrigated sections have shown that organisms capable of causing diseases of potatoes are probably present in all desert lands, but that land previously in cultivation with grains and alfalfa may, when disease-free seed is planted, produce a crop comparatively free from disease. In southern Idaho the experiments on the control of powdery dry-rot in storage have been completed and show that the losses can be prevented by careful harvesting to avoid mechanical injuries and by keeping the storage cellar at a temperature between 35° and 40° F., with proper ventilation. When it is necessary to store in poorly ventilated or improperly cooled houses, the disease may be effectively checked by disinfection with corrosive sublimate or

formaldehyde, provided this is done within 24 hours after digging. Further surveys have indicated that the powdery scab disease is confined to six sections of the United States, all of these being northern except one locality in Florida. In every case these areas are in sections with considerable rainfall, where soil conditions are such that poor drainage prevails. It has been found that the disease can be lessened by the application of seed and soil treatments. The cause of potato "leak," a rapid type of decay causing serious loss in the delta district of California, has been discovered, and experiments have shown that it can be controlled to a marked extent by careful harvesting and sorting before shipment.

FOOT-ROT OF SWEET POTATO.—Foot-rot of the sweet potato has been found to be a serious and destructive disease in several States. Successful methods for its control have been discovered and demonstrated, and studies of the resistance of varieties to the disease and of its relations to storage rots are being made.

COTTON DISEASES.—With the cooperation of the States Relations Service, work on the control of wilt, root-knot, and anthracnose of cotton, forage crops, and truck crops in the South has been considerably increased. Last season 1,545 acres of wilt-resistant cotton were planted by cooperative breeders and growers in South Carolina and 5,030 bushels of selected seed produced for sale to farmers. In Alabama, where the work was begun only last year, 170 bushels of selected seed were produced.

WATERMELON ROT.—During the past two years a constantly increasing number of reports of serious losses due to the deterioration of watermelons in transit to northern markets have been received. The investigation of these troubles was begun a year ago, and it has been determined that at least 90 per cent of the loss reported was due to a stem-end decay caused by a species of *Diplodia*. Field experiments to control this fungus are yielding promising results.

OAT BLAST.—A cooperative experiment with the Bureau of Entomology has been initiated at La Fayette, Ind., to determine the cause or causes of the infection commonly known there as oat blast.

WHEAT RUST.—Many data have been obtained during the year on the subject of rust resistance of both wheat and oats and on rust-resistant wheat hybrids. Studies conducted in cooperation with the Minnesota Experiment Station have revealed important relations between the rusts of certain wild grasses and those of cultivated cereals. Additional information has also been obtained on the distribution of the new stripe rust disease.

WHEAT SMUT.—A device has been originated which promises a more satisfactory and practical application of the hot-water treatment for the prevention of loose smut of wheat and barley.

CROWN-GALL.—Extensive researches upon the development of crown galls upon plants show that these galls, which are caused by a bacillus, have very many points of resemblance to human cancer.

DAMPING-OFF OF CONIFERS.—Experiments in many widely separated localities, as well as the cooperative experiments of the Forest Service on a commercial scale, confirm our earlier report on the efficiency of

sulphuric acid as a fungicide in controlling the damping-off disease of coniferous seedlings. In certain localities presenting peculiar soil conditions, zinc chlorid and copper sulphate have proved more effective. These fungicidal treatments also kill weeds, and at some nurseries this feature alone pays for the cost of applying treatment. An unexpected result from this fungicidal treatment is the stimulation of growth of the conifer seedlings.

NEW TREE DISEASES.—Nine newly imported tree diseases have been discovered and studied and with one exception destroyed by cooperating authorities so far as found. The exception is a newly imported poplar disease from Europe, *Dithichiza populea*, which is apparently already so widely distributed by nursery stock as to preclude any organized attempt toward eradication.

WHITE-PINE BLISTER RUST.—Only a provisional report can be made, as the season's work is incomplete. The blister rust is now epidemic on currants practically throughout Massachusetts, Rhode Island, southern New Hampshire, and northwestern Connecticut. Elsewhere it appears to be well under control, although there are dangerous outbreaks on the Niagara peninsula in Canada and in an area in Wisconsin and Minnesota not far from St. Paul. No trace of the disease has yet been found west of Minnesota. Many nurseries are situated within the areas of the currant-disease epidemic, and the danger of spreading the disease by nursery stock of either currants or white pines is as great as it ever has been.

CEDAR RUST ON APPLES.—Cedar rust on apples continues to attract considerable attention and has been severe in certain localities. One of the striking things, however, in orchard pathology has been the fact that in many of the large commercial orchard districts of the eastern Appalachian Mountains where cedar rust threatened the destruction of the value of the orchards, complete or partial eradication of the cedar trees in the vicinity of the apple orchards, usually within a radius of 1 mile, has completely solved the problem in the most practical, simple, and permanent way and at very slight expense. While the destruction of the red cedars is to be regretted, this tree in the vicinity of apple orchards has come to be a veritable pest tree, and where the cedar-rust fungus has been specially abundant the necessity for its destruction has been amply demonstrated by the repeated experiences of the past few years.

CITRUS SCAB.—This disease has become increasingly destructive during the past few years in Florida, especially in grapefruit groves, and investigations were undertaken to extend our knowledge of the life history of the scab fungus in all its details and further to perfect the methods of control. Spraying experiments carried on indicate the possibility of satisfactory control by thorough spray protection of the young fruit.

APPLE BITTER-ROT.—Practical field tests in perfecting the methods of control of apple bitter-rot have been carried on in the Ozark section with very satisfactory results. The removal of cankers and diseased fruit supplemented by spraying reduced damage by the disease to 2 per cent on early varieties and 1 per cent on late varieties. The orchard in which these field tests were conducted had previously,

despite the best efforts in spraying, lost from 10 to 25 per cent each year. Adjacent orchards during the year lost about 50 per cent on early varieties and 25 per cent on late varieties.

PEACH AND PLUM SPOT.—The bacterial spot on peach and plum has not proved amenable to spray treatment. Experiments in controlling this disease by means of nitrate of soda applied to the soil were tried out on a large scale with complete success. The life history of the organism causing this disease is being studied.

STIGMONOSE OF FRUITS.—The work of the present year has given further confirmation of the previous year's experiments and established the connection of certain insects with particular types of fruit spotting. Experiments on rosy aphid stigmonose have been carried out at Staunton, Va., and similar work has been carried on in co-operation with the Bureau of Entomology at Wenatchee, Wash. The work in Virginia has shown conclusively that much of the so-called "York" spot of the Eastern States is stigmonose due to insects. This type of disease is, therefore, capable of control by spraying methods developed by the Bureau of Entomology. Experiments have been made in the control of this disease, and the first year's results of spraying show that the fruit from sprayed plats will stand up in shipment far better than the fruit from unsprayed plats.

PLANT PHYSIOLOGICAL INVESTIGATIONS.

CLOVER-SICK SOILS.—Experiments in clover-sick regions are now being started in cooperation with the Indiana experiment station and with the Winconsin experiment station. The results so far obtained indicate that with the incorporation of certain green manures, together with the proper fertilizer treatment, clover sickness can be controlled or sufficiently overcome to make clover growing again profitable in these regions.

NEW SOIL COMPOUNDS.—The fundamental investigations into the nature of organic soil constituents and the chemistry of humus in general have progressed, and in the course of the year several definite organic acids which throw light on the decay of organic matter of soils have been isolated. An especially interesting acid with peculiar properties has been isolated from a very unproductive soil and recommendations for its elimination under field conditions made as a result of our studies. An organic colloid of complex carbohydrate nature which has a marked influence on physical and biochemical properties of the soil has been isolated and studied. The field studies on the action of harmful soil constituents have been continued under different soil and climatic conditions at the Arlington Farm, Pennsylvania Agricultural Experiment Station, and the Cornell Agricultural Experiment Station. In different soils these compounds exhibit a different intensity of action, which is shown to be due to a partial or complete destruction of the compound under the existing soil conditions. The influence of fertilizers on different compounds as they exist in soils is practically found to be specific, and this fact is being utilized in conducting field demonstrations to free the soil from these compounds where they have been encountered.

WATER REQUIREMENT OF PLANTS.—The study of the water requirement of plants has been continued during the past year with a view to determining the crops and varieties most efficient in the use of water. The differences exhibited in this respect by the principal crop plants are remarkable. Millet, sorghum, and corn are the most efficient in the use of water. Wheat and the other small grains form an intermediate group, while alfalfa and other legumes have the highest water requirement. Alfalfa uses about three times as much water as millet in the production of a pound of dry matter when the two crops are grown side by side. Varieties of the same crop show in some instances marked differences in water requirement, so that the careful study of different varieties from this standpoint is a matter of decided economic importance in connection with the agricultural development of dry-land regions.

MOTTLE-LEAF.—Investigations regarding the cause of mottle-leaf of citrus trees in southern California have shown that about one-half of the mottle-leaf can be accounted for by the low humus content of the soil. The trouble appears also to be due in part to poor distribution of the irrigation water and a concentration of mineral plant food in the topmost layer of soil, where it is useless to the tree.

INDICATOR VALUE OF NATIVE VEGETATION.—Investigations in southern Arizona and southeastern California demonstrated that in this region certain types of vegetation indicate that the soil contains too much alkali for successful crop production; others indicate that the land is not too salty to be easily reclaimed under irrigation; and still others indicate that alkali is absent or present only in negligible quantity. The texture and moisture-holding capacity of the soil and its suitability for the production of different classes of crops are also indicated with a high degree of accuracy by the character of the native growth. In view of the great areas of land in the Southwest which are still in their original state but of which a portion is capable of crop production, the establishment of these definite correlations is believed to be of considerable practical importance.

PLANT-BREEDING INVESTIGATIONS.

ALFALFA.—The introduction and breeding of hardy and drought-resistant strains of alfalfa are being prosecuted as vigorously as possible. An especially promising new strain has been secured from India, which seems to be well adapted for use in the Southwest. Investigations to determine the cause of "yellowing" of alfalfa and to develop a practical treatment for this trouble, which is a serious handicap to the culture of the crop in many parts of the East, indicate that the stage of maturity at which the crop is cut has much to do with the degree to which the succeeding crop is affected.

CLOVER.—The pollination studies of red clover carried on in cooperation with the experiment stations in Iowa and Indiana show that cross-pollination is absolutely essential to the setting of the seed; that honeybees are very important as pollinators; and that all the mechanical methods of pollination that have been suggested and tested are of no practical value. The increased plantings of sweet clover, due in a large measure to the recommendation of the bureau,

are in many areas rapidly replacing red clover. Extensive investigations have been conducted with sweet clover in determining the best methods of culture. As a result of this work, manuscripts for two Farmers' Bulletins are now ready for publication. Field tests with the crimson-clover seed-harvesting machine devised by this bureau have given exceedingly satisfactory results.

SOY BEAN.—During the past year notable progress has been made in bringing about the commercial utilization of soy-bean seed for the manufacture of oil, meal, and various more or less complex products. The soy bean is well adapted to the whole cotton belt and indeed to the whole corn region. In the cotton belt it promises to be an important crop wherever the acreage of cotton has been reduced. The immature bean seeds make a very delicious vegetable and are canned with ease. Inasmuch as soy beans can be more cheaply produced than any other bean seed, it is believed that there is a large field for the canning of green soy beans. Efforts are now being made to induce canning factories to put the product on the market. In the growing of the soy bean and in manufacturing products therefrom the United States can compete successfully with the Orient.

SUDAN GRASS.—Tests of Sudan grass in cooperation with State experiment stations were continued during the past year and a large body of accurate knowledge obtained concerning the crop. Seed production north of the region where Johnson grass is abundant has been encouraged, with the result that there is now available a good supply of pure seed which can be purchased at reasonable prices. The lower prices of seed have greatly encouraged the growing of Sudan grass for hay.

CACTUS.—Cactus investigations have been continued in the extensive cactus garden at Chico, Cal. Breeding work has resulted in the production of a number of new forms, some very promising as forage plants, others for fruit production.

VETCH.—Vetch investigations are being continued in cooperation with the Oregon experiment station and some of the species of vetch have been hybridized. An especially interesting hybrid is that between *Vicia sativa* and *V. augustifolia* which, from the known characteristics of these two species, is likely to prove of very high importance on the south Atlantic coast.

NATAL GRASS.—A notable development during the past two or three years has been the interest in Natal grass in Florida. A very large acreage of this grass is now being grown for hay, and in some sections it is coming to be regarded as a basis for land values. Natal grass was introduced by the department some 25 years ago, and while its culture has been urged in a conservative way in various publications, it is only within the past few years that it has made the progress its high merit deserves. Natal grass promises to produce all of the hay required in Florida and will probably furnish a surplus for export from that State.

HEMP.—Marked improvement has been made by continued selection with the progeny of the best plant of the Minnesota No. 8 variety of hemp. The original plant was 10 feet 5 inches high. The tallest plant in 1914 was 13 feet 4 inches, and in 1915 the tallest plant was

16 feet 8 inches. The entire plat in 1914 averaged 9 feet 11 inches in total height and 4 feet 5 inches to alternate branches. In 1915 the average in total height was 12 feet 8 inches and 5 feet 9 inches to alternate branches. The marked improvement in the plants, especially in the uniform type with long internodes, indicated by the increased height to alternate branches, warrants a distinctive name. It is called "Kymington," indicating Kentucky seed improved by selection in Minnesota and Washington.

DATES.—The date-breeding work which has been under way for the past 10 years at the Government date garden, Indio, Cal., has been given new impetus by the prohibition of all further export of date offshoots from the French possessions in North Africa, the source of the finest commercial varieties up to the present time. As the war conditions have made it impracticable to import from other regions, all importations of date offshoots from abroad have ceased. Many new seedling date varieties are being originated in America, some of which are apparently equal to the finest that have resulted from 3,000 years of date culture in the Old World.

FRUIT IMPROVEMENT THROUGH BUD SELECTION.—The work of keeping performance records of select trees of the Washington Navel and Valencia oranges, Eureka, Lisbon, and Villa Franca lemons, Marsh grapefruit, and Dancy tangerine has been continued during the year. Deciduous-fruit performance records on select trees of Carman, Elberta, Hale, and Belle peaches and Baldwin, Ben Davis, and Northern Spy apples have also been kept. In addition to these records, a tree census has been obtained, showing the conditions of established commercial orchards in regard to the uniformity of type of trees and fruits borne by such trees. More than 200,000 select fruit-bearing buds from citrus trees with known performance records have been placed in the hands of cooperators who are to permit the department to secure progeny records from the trees so propagated. These buds are not only for the propagation of nursery stock, but in many cases for the top-working of unprofitable trees in established plantations. Recently, in cooperation with the California Fruit Growers' Exchange, a systematic campaign has been undertaken to eliminate all of the inferior strains of grapefruit in California by top-working trees of such strains with select buds from trees of the Marsh variety with known performance records, thus reducing the grapefruit production of the State practically to the basis of a single variety. Each year sees an increase in the number of citrus growers in California who adopt the commercial tree performance record system for locating trees of unprofitable character, either because they bear little fruit or because they bear fruit of a strain not well suited to commercial use. A second commercial nursery has been established during the year in California for the purpose of propagating trees from wood borne by record individuals.

IRISH-POTATO INVESTIGATIONS.—The potato investigations are conducted chiefly at Presque Isle, Me.; Greeley, Colo.; Jerome, Idaho; and Norfolk, Va. One of the main features of the work is the development, from seed, of new varieties of potatoes specially suited for certain purposes and adapted to the special growing regions in

which such products can most economically be produced. A large number of seedlings have been grown and only those of greatest promise retained, of which there are some 300 considered of sufficient value to warrant further testing. These are being tried out in co-operation with the various State stations, and as soon as they have proved their worth in any section arrangements will be made to establish the variety in the region to which it is best adapted.

AGRONOMIC AND HORTICULTURAL INVESTIGATIONS.

CORN.—Effective methods of corn breeding have originated higher yielding varieties of corn. For the best results in any locality local adaptation and selection must follow the origination of higher yielding varieties, the lasting benefits of which depend upon a broad understanding of corn variations and the fundamental requirements of the crop. Methods of planting by which one or two rows of an early-maturing variety alternate with one or two rows of a later maturing variety have given higher yields than either variety planted alone. Where there is likely to be a shortage of moisture during certain periods of the growing season, dependence should not be placed in a single variety; under such conditions two or three varieties which differ considerably in length of growing season should be grown.

SUGAR BEETS.—Sugar-beet seed was grown commercially in this country during the past year in several States, from Michigan to California. The crop of seed harvested in 1915 was so satisfactory in each of the areas tested that a largely increased acreage was planted this year. This bureau has assisted in an advisory way in growing, selecting, and siloing the roots, planting them in the spring, harvesting and cleaning the seed, and, in general, has endeavored to produce the largest amount of commercial seed possible at a minimum cost. Approximately 5,000 acres are in beet seed in this country this year, while we require the product of at least 16,000 acres for a normal planting, not considering the natural expansion of the beet-sugar industry. Each new mill will require an average of 200 acres in seed to meet its planting requirements. Seven new mills are in process of construction for this year.

The problem of drying the sugar beets for the purpose of increasing the amount of raw material for the mill and thereby increasing the length of the sugar campaign has been further investigated. The principal difficulty has been in finding or devising a drier of suitable capacity to handle enough beets per day to be profitable. A satisfactory solution of the problem will be very beneficial in those small valleys in the intermountain States where the acreage is not sufficient to support a sugar mill and yet the sugar beet is necessary to the highest results in the farming operations.

FRUIT-PRODUCTION INVESTIGATIONS.—The results of these investigations make it possible to outline six fairly well defined pomological districts in West Virginia, Kentucky, and Tennessee as a unit of territory, the divisions being based principally on physiographic and climatic features and the behavior of the fruit varieties grown in these different sections. The behavior of fruits grown in these different districts has been determined through repeated observations

in several seasons, so that it is now possible to name varieties that are best adapted to the different purposes in the several districts. Important conclusions have also been reached as to the relative adaptability of the different districts to fruit growing. Conditions in one or more of them are such as to render commercial orcharding inadvisable, and in others it should not be undertaken with a view to its becoming a main dependence as a source of income. The problems of fruit growing, that is, the technique of orchard management, have received considerable attention. An effort is being made to prepare as rapidly as data can be accumulated a comprehensive series of publications treating of the culture of the different fruits. During the past year particular attention has been given in this connection to cherries, figs, dewberries, strawberries, currants, gooseberries, oranges in the Gulf coast region and California, avocados, mangos, and limes.

STUDIES OF NEW CROP PLANTS AND CROP EXTENSION.

SEED DISTRIBUTION.—During the fiscal year 1916 there were distributed on congressional and miscellaneous requests 12,417,972 packages of vegetable seed and 3,754,870 packages of flower seed, or a total of 16,172,842 packages, each containing 5 packets of different kinds. There were also distributed 14,202 packages of lawn-grass seed, 819 packets of tobacco seed, 10,364 boxes of narcissus and tulip bulbs, and 96,000 strawberry plants, comprising 16 varieties.

A distribution of new and rare field seeds was made throughout the entire United States, having for its object the dissemination of seed of new and rare forage crops, seed of improved strains of staple forage crops, and high-grade seed of crops new to sections where the data of the department indicate such crops to be of considerable promise. Each package contained a sufficient quantity of seed for a satisfactory field trial, and the recipient was urged to use the seed, if feasible, for the production of stocks for future plantings. A report card and circular giving full directions for the culture of the crop accompanied each package of seed. This distribution included the following: Grimm, Baltic, Canadian Variegated, Peruvian, Kansas-grown, Dakota-grown, and Montana-grown alfalfas; Sudan grass; Dwarf Yellow milo; Dwarf hegari; Dakota Amber and Sumac sorghums; Kursk, Siberian, and Turkestan varieties of millet; Kaiser, Bangalia, Bluebell, French June, and Golden Vine varieties of field peas; Brabham, Groit, Catjang, and Early Buff varieties of cowpeas; Black Eyebrow, Haberlandt, Mammoth Yellow, Manchu, and Tokyo varieties of soy beans; Chinese, Early Florida, and Yokohama varieties of velvet beans; Natal grass and Rhodes grass; and Columbia, Dixie, Durango, Holdon, Lone Star, and Trice varieties of cotton. During the year 339,742 packages of new and rare field seeds were distributed, including 120,943 packages of cotton seed. Such a distribution enables a farmer to procure seed of new and improved crops in sufficient quantities to produce stocks for future seeding, the general effect of which is gradually to improve the crops of the country.

BLUEBERRY CULTURE.—The cooperative work of the blueberry plantation at Whitesbog, N. J., has been continued with highly satisfactory results, and initial plantings at the cranberry station at East Wareham, Mass., have been made in cooperation with the Massachusetts Agricultural Experiment Station. Blueberries thrive best in soils so acid as to be considered worthless for ordinary agricultural purposes. Blueberry culture, therefore, offers a profitable industry to individual landowners in districts in which general agricultural conditions are especially hard and unpromising and suggests the possibility of further utilization of acid lands by means of other special crops.

SISAL FIBER.—The conditions relating to henequen (Yucatan sisal), from the fiber of which more than 80 per cent of the binder twine is made, continue to be unsatisfactory. The extraordinary increase in the price of the fiber and the constant apprehension lest supplies from this one source be still further restricted or cut off compels attention to the development of new sources of supply. The consumption of henequen in the United States has increased an average of 40 per cent in geometrical progression each five years since 1890, and at this rate of increase it will be imperative to seek new sources of supply irrespective of the conditions in Yucatan. Practically all of the henequen produced in Yucatan is used in the United States, and an adequate supply at reasonable prices is of prime importance to American farmers. Preliminary experiments indicate that henequen can not be grown successfully within the boundaries of continental United States, but every possible effort should be made to foster its cultivation in our tropical islands or in other lands adapted to its production.

COTTON.—The advantages to be gained through community action in cotton growing were first stated in 1911, and since that time they have been emphasized in a number of publications on the improvement of the cotton industry by more efficient application of the results of scientific investigations. Meanwhile, convincing demonstrations of these advantages have been afforded by the success of community action in the production of Egyptian cotton in Arizona and Durango cotton in the Imperial Valley of California. The success of these organizations is attracting attention to the desirability of forming similar associations of cotton growers in other parts of the cotton belt, and special cooperation is being extended to such communities.

The results of experiments made in the Southeastern States indicate that Texas big-boll varieties of cotton are superior in several respects to the small-boll varieties regularly grown in this part of the cotton belt. The western cottons not only do better there in a normal season, but they appear to be less susceptible to injury from extreme conditions, both of drought and wet weather. The latter advantage is due to the fact that rain often fails to penetrate the more abundant fiber that clothes the seeds of the big-boll varieties. Lone Star, a Texas big-boll variety, originated by this bureau, has done especially well in South Carolina, showing the wide range of adaptability of this variety and indicating the possibility of substituting varieties of this type for the more common and less valuable ones of the Southeastern States.

The growing of the Durango variety of cotton, which has been shown to be adapted to wide variations in natural conditions, has been further extended in different parts of the cotton belt. Approximately 30,000 acres of Durango cotton are being grown in 1916 in the Imperial Valley of California, where this variety has proved to be more drought resistant and better adapted to irrigation culture than other long-staple Upland varieties. At the other extreme of the cotton belt, in the vicinity of Deep Creek and Holland, Va., about 1,600 acres of Durango are being grown. This variety is also meeting with favor in other communities in South Carolina, Alabama, northern Oklahoma, and also in the dry climate of western Texas.

The Acala variety of cotton, recently acclimated from Mexico by this bureau, shows some points of superiority over the more common varieties in northern Texas and in Oklahoma and promises to be rapidly extended into general cultivation in those regions. It is distinctly earlier than Rowden, Lone Star, and Triumph, now the most popular varieties, and its lint is longer and of higher quality, being unusually strong. Its earliness makes Acala specially attractive on the bottom lands, where cotton tends to grow rank and be late in reaching maturity, and on the northern high lands, where the frost shortens the growing season.

The new system called single-stalk culture has contributed to the establishment of the Egyptian cotton industry in the Salt River valley of Arizona. As applied to the Egyptian cotton, the new system not only induces earlier fruiting and tends to insure larger crops, but greatly facilitates the picking of the cotton at the end of the season. Thus the cost of production is lessened, while the yields are increased.

The single-stalk system of controlling the branching habits of the cotton plants has made possible a special method of culture for irrigated districts. The rows are planted in pairs, one on each side of a large furrow. Irrigation is confined to the furrows, and these are separated by broader ridges that remain as a permanent mulch of dry soil. The water is applied more effectively, germination and growth of the young plants are more uniform, and less labor is required for cultivation and the control of weeds. The plants soon shade the furrow, but the broader space above the ridges is kept open through the season, with the vegetative branches suppressed by the single-stalk system. If the plants grow very large they lean away from the furrow over the dry ground. This makes it possible for irrigation to be continued later in the season without interrupting the harvest or damaging the ripe bolls, so that larger crops of good fiber can be matured.

FOREIGN PLANT INTRODUCTIONS.—The plantings of the oriental timber bamboo in northern Florida and Louisiana have grown to a height of 25 feet, and there is no longer any question about their producing in this country good canes comparable to those which they produce in China and Japan. A quick method of their propagation has been worked out, so that it will now be possible to supply large enough quantities of the young plants to set out many small areas throughout the South, from the Carolinas to California, wherever there is sufficient moisture and the land is not too high priced to

admit of their cultivation. Both in the Louisiana and the California plantings of the timber bamboo there appeared this year an outbreak of the bamboo smut (*Ustilago shiraiana*), and because of the damage which this disease is reported to cause to the bamboos of Japan, the affected clumps were sprayed with gasoline and burned to the ground and propagation at these points stopped. These two points of infection in America are believed to be the only ones in this country at the present time.

Since the bureau first sent out inarched plants of the Chinese litchi (*Litchi chinensis*) in 1909 the question of the hardiness of this species of tree producing delicious fruits has been under observation. It appears from the behavior of a single seedling about 14 years old in California and of inarched trees in Florida which are now 7 years old and have this season borne their first few fruits that there are areas in Florida and California where this fruit tree may be expected to live and bear if the young plants can be protected, or at least escape severe frosts until they become thoroughly established. The quality of the fruits produced in this country is excellent, and their appearance and shipping quality are certain to insure their easy sale on the fresh-fruit market. The dried litchi "nut," of which there are imported into this country over \$300,000 worth every year, is in no way to be compared to the fresh fruit in quality, although it resembles it in appearance.

The acquisition through the gift of the municipality of Tokyo of bud wood from the famous Arakawa collection of flowering cherry trees and their propagation on introduced Japanese cherry stocks has put the department in a position to give a wide trial in the near future to the hardiness of these superbly beautiful trees as doorway and park trees.

The behavior of the Guatemalan varieties of avocado in California and the fruiting of two of the early introductions of this fruit from Guatemalan species which were secured two years ago have made the prospects of the cultivation of this important fruit plant in Florida seem sufficient to warrant the distribution of grafted plants of the winter-fruiting Guatemalan forms to experimenters engaged in this new fruit industry.

The Chinese downy chestnut trees (*Castanea mollissima*) which were distributed in 1907 have not succumbed to the bark disease and some of them have borne a few fruits. It is clear that they have a high degree of resistance to disease, and although they can not be expected to take the place of the much larger species of chestnut native to America in so far as timber production is concerned, they can at least be relied upon to furnish good nuts for the trade.

CROP UTILIZATION.

FLAX TOW FOR PAPER MAKING.—Commercial tests, conducted in co-operation with a fiber-board manufacturer in 1914, demonstrated that domestic flax tow could be substituted for imported flax waste in the production of counter and toe board used in shoe manufacture. Both the process of manufacture and the product were satisfactory, but it was found that the price of domestic flax tow made its use commercially impossible. More recent tests have demonstrated that domestic flax tow can be used in the production of tough wrapping,

flour-sack, and cement-sack paper, but again the cost of the flax is prohibitive. A tow machine which will produce a better grade of tow containing a higher fiber content has been devised. Laboratory tests on better grades of tow demonstrated that better paper could be produced and that a less expensive process could be employed in manufacturing it.

AGRICULTURAL DEVELOPMENT OF RECLAMATION PROJECTS.—Approximately 50 per cent of the cropped area of the reclamation projects is devoted to the production of forage crops and about 30 per cent to the production of grain. Since these crops usually can not carry the cost of transportation from the projects to the large consuming centers, their profitable disposal and utilization necessitate the establishment of live-stock industries through which these crops can be converted into more marketable commodities. On a few of the projects acute problems of production affect all crops. On a larger number of the projects production problems are encountered in connection with crops necessary to supplement other crops which are produced abundantly.

During the year demonstration work in dairying has been conducted on the Truckee-Carson, Huntley, Minidoka, Tieton, Shoshone, Boise, and Uncompahgre projects. In this work the settlers have been assisted in securing stock, improving local dairying herds through breeding and cow testing, controlling diseases, planning and constructing barns and silos, and in improving their methods of feeding and marketing.

Work in connection with the establishment of the swine industry is in progress on the North Platte, Truckee-Carson, Huntley, Minidoka, Tieton, Shoshone, Boise, and Uncompahgre projects. The settlers on these projects have been aided in solving the problems of breeding, feeding, housing, and marketing their hogs, and in the control of diseases, particularly hog cholera.

The beef and sheep industries have received attention chiefly on the Minidoka, Tieton, Boise, Shoshone, and Uncompahgre projects. The two principal activities in this connection during the year have related to cooperative action in the use of adjacent range lands and in eradicating blackleg among beef cattle.

On the Truckee-Carson project the poultry industry is proving very useful in the utilization of waste grain. The industry has made rapid growth during the past year. The principal activities in connection with this industry have been directed toward establishing a better understanding of market requirements and community marketing and in interesting outside buyers in the local produce. As a result of these activities, approximately 100,000 pounds of poultry was marketed from the project during the months of November and December, 1915.

ORANGE OIL.—A machine has been invented which successfully removes the oil-bearing portion of the rind of waste and cull oranges and other citrus fruits, thus making it possible to eliminate a large part of the expensive hand labor which has heretofore rendered the domestic production of sweet-orange oil commercially unprofitable. This machine has been patented and dedicated to the public. There has also been devised a simple, practical, and inexpensive method of manufacturing sweet-orange oil from the rind of cull and waste fruit removed by the machine mentioned.

NEW INSECTICIDES.—The search for new sources of plant insecticides, in cooperation with the Bureau of Entomology, has shown some striking results. The most promising source thus far examined is *Amianthium muscaetoxicum*, known locally as fly poison or crow poison, the decoction of which, used as a spray, successfully controlled potato beetles and the fall webworm.

INVESTIGATIONS OF CROP HANDLING AND STANDARDIZATION.

APPLE STORAGE.—The results of the investigations in the handling of northwestern apples for and in cold storage have been so consistent and conclusive that this phase of work may be considered completed. The results brought out particularly the importance of picking apples of various varieties at the proper stage of maturity, of careful handling in all harvesting and storage operations, of prompt cooling, and proper storage temperatures. During past seasons the growers have frequently suffered very large financial losses from either too early or too late harvesting of apples of certain varieties, such as Jonathan, Rome Beauty, and others. The work has demonstrated clearly that the storage life of apples can be prolonged from weeks to months by picking at proper maturity, and has shown how the grower may know when his fruit is of proper maturity for best results in storage. In connection with the investigations of the cold storage of Yellow Newtown apples in the Watsonville district in California, the most important discovery is without doubt the relation of tree vigor to the keeping quality of fruit in storage. Experiments extending over two seasons have clearly shown a marked and consistent difference in the keeping quality of fruit from different trees, particularly trees that for any reason differ in vigor and general healthfulness. During the past season the possibilities of common, or air-cooled, storages in different sections were carefully investigated. The results of these investigations have clearly shown the practicability of such storage under some conditions and the economic saving resulting to the industry in the use of houses properly constructed and managed.

INVESTIGATIONS OF TEMPERATURES OF FRUIT IN TRANSIT.—The results of fruit-handling investigations during the past few seasons show that the most important factor in determining the condition of either fruits or vegetables in transit and after arrival on the market is the temperature maintained in refrigerator cars during transportation. All fresh fruit is alive, and the life activities continue with greater or less rapidity until it goes into consumption; the temperatures maintained in transit determine to a great degree both the rate of ripening and the development of fungi and other decay-producing organisms.

The investigations during the past season have had mainly in view the improvement of refrigerator-car equipment, especially as regards insulation and facilities for free air circulation. The results of the work thus far have shown that through certain modifications in the ice bunkers, through the use of racks or false floors, and through better insulation, it is entirely practicable to increase the efficiency of refrigeration and to haul larger loads of fruit than formerly and with a lesser ice consumption.

The results are particularly of importance to the shippers in that it appears certain that uniformly better refrigeration can ultimately

be provided at a lesser cost. Probably the most important development in connection with these investigations is the practicability of using small amounts of salt during the first two icings in cars with modified bunkers and racks, to accomplish a quick cooling, comparable to precooling in either warehouses or car precooling plants, with practically no extra cost and no delay for precooling. Under this method the packed fruit is subjected to no handling other than that necessary to place it in the car as it is ordinarily loaded. It also makes possible the long shipment of tree-ripened or more fully matured fruit in good condition, thus supplying the consumer with a product possessing its maximum fine quality.

MUSKMELON HANDLING.—Investigations in cooperation with the Bureau of Chemistry were inaugurated in 1916 for the purpose of determining the proper time for picking muskmelons and the best methods of handling the crop. The work in California during 1916 demonstrated the necessity of more careful handling. A large percentage of the deterioration in transit and on the market was traced directly to rough handling in the field and in the packing and loading sheds. When melons are picked before ripening, the deterioration is less than in riper fruit, but a large part of the crop reaches the eastern market in a condition unfit for consumption.

GRAIN GRADING AND HANDLING.—During the year a patent covering the grain and seed sampling device which was invented in 1915 was applied for and granted. This patent was dedicated to the people of the United States.

One of the principal factors in determining the proper commercial grade of grain, except corn, is its test weight per bushel. A slight variation in the method of filling the test kettle and of stroking the excess grain from the top of the kettle, will cause a serious error in the resulting test weight and consequent grade. The investigations have shown that there are many methods of determining the test weight per bushel of grain and that the varying results often give rise to serious disputes as to the true test, a special apparatus with which uniform results can be obtained by any careful worker has been devised and adopted as the standard apparatus and method for making this test.

Studies of the methods of handling and grading grain and especially of the "dockage of wheat as it is delivered to elevators and mills have shown that there are three principal methods by which the problem is handled commercially and that these methods vary with different localities or sections. The methods are (1) the grain is bought as it is delivered, but the grade and price paid for it are lowered in proportion to the amount of "dockage"; (2) the grain is delivered without cleaning, but the "dockage" is determined from a small sample by means of sieves, and the grade, weight, and price are then based on the clean grain; and (3) the grain is delivered without cleaning, but the elevators or mills remove this "dockage" and return it to the farmers before weighing and grading the grain.

Investigations relating to the sulphur bleaching of commercial oats have demonstrated that the sulphur not only bleaches the hull of the oat kernel but the berry as well; that the damaged oats are less apparent in the bleached than in the unbleached grain; and that the bleaching process materially reduces the germinating qualities of

the oats in most instances. Progress has also been made in developing chemical methods for determining the class of wheat, as to whether it is hard or soft, and for determining the degree of damage in oats.

Investigations have shown that wheat grown in dry-land territory frequently has a very low moisture content when harvested and that when wheat of this nature is transported to the more humid climates of the seashore it will absorb considerable moisture and show a noticeable increase in weight if allowed to remain there in storage for some time.

It has been shown, also, that by thoroughly mixing dry old wheat from the previous year with the new wheat, which is frequently damp, and putting it into bulk storage for a few days the dry wheat absorbs a sufficient amount of the moisture from the damp wheat to improve both kinds for milling purposes.

INVESTIGATIONS IN QUALITY OF SEED.

SEED TESTING.—During the fiscal year 1916, there was a gradual increase in the number of samples of seed submitted for test to the Washington seed laboratory, as well as to the cooperative branch laboratories. Owing to the unusual conditions in Europe, the normal supply of winter-rape seed was unavailable, and much other seed was imported under the name of rape. Seed purchased in the open market as winter rape showed that seeds of seven other types of plants, all unsuitable for forage purposes, were being sold under this name. Tests of imported seeds have shown that large quantities of red and crimson clover seed brought into the United States germinated so poorly as to be of little or no agricultural value, and that much of the orchard-grass seed contained but a small proportion of good seed, the balance being mostly chaff. The seed importation act has now been amended, prohibiting the entry of such low-grade seed. Through the enforcement of the seed importation act a large amount of low-grade red-clover seed offered for import into the United States has been recleaned and the screenings destroyed under customs supervision.

The amount of important crop seeds imported in the past year varied greatly from that imported in previous years. Only about one-half as much alfalfa seed was imported as in either of the three previous years, and the imports of crimson-clover seed were less than half of those of the two previous years. Of hairy-vetch seed less than 70,000 pounds were imported, as compared with 2,500,000 pounds in 1914 and 500,000 pounds in 1915. The imports of both winter-rape and red-clover seed exceeded those of any previous year, enough red-clover seed being brought in to seed over 4,000,000 acres at a normal rate of seeding.

REPORT OF THE FORESTER.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, October 2, 1916.

SIR: I have the honor to transmit herewith a report of the work in the Forest Service for the fiscal year ended June 30, 1916.

Respectfully,

HENRY S. GRAVES, *Forester.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

THE NATIONAL FORESTS.

The outstanding features of the year in National Forest administration were:

(1) A marked increase in receipts, which were greater by \$342,071.36 than in 1915 and totaled \$2,823,540.71.

(2) Rapid progress in land classification, of which the object is to segregate and open to settlement all lands best suited to agricultural use while retaining in public ownership the lands which are essential for National Forest purposes. This work is of great importance in fixing on a permanent basis the lands which are to be retained in the National Forests.

(3) Material progress in development work in the National Forests, which is reflecting itself in an increased use of the resources, larger volume of business, and the advancement of the interests of the local communities. The building of roads in regions hitherto inaccessible is one of the largest factors in this development work.

(4) Gratifying results in forest protection during an exceptionally prolonged fire season (the summer and fall of the calendar year 1915), during which more than 6,000 fires were controlled with a relatively small loss.

The increase in receipts was chiefly derived from timber and grazing. The timber receipts were \$1,412,592.51, an advance of \$257,458.56, or 20 per cent, and the grazing receipts \$1,210,214.59, an advance of \$79,719.59. Water-power rentals brought in \$101,096.32, or \$12,145.88 more than in 1915, and occupancy for other special uses \$85,235.30, an increase of \$7,177.98; while turpentine rights yielded \$14,401.99, an increase of \$5,569.35.

In addition to the cash receipts the equivalent of a large revenue was foregone through the various forms of free use and the sale of timber to settlers at cost instead of at its actual cash value. During the past year there was given to settlers free of cost approximately 120,000,000 feet. The Forest Service has authority to sell at cost to settlers timber required for domestic use. During the last fiscal

year such sales amounted to 23,317,000 feet. The privilege of grazing a small number of stock free of charge is granted to settlers living on and near the Forests. The aggregate number of stock thus grazed on the National Forests amounts approximately to 125,000. The National Forest lands are put to many special miscellaneous uses for which no charge is made, though their administration involves some expense. Strict accounting should credit the fair value of such uses to the receipts from the National Forests, for it is in effect Forest income which, instead of being put into the Treasury, is made available for the benefit of the public.

The business on the National Forests is on a thoroughly sound basis. An efficient organization has been built up to handle the work of protection of the Forests and of developing the resources. The rapidly increasing use of the Forests points not only to constantly greater service to the public, but also to increased financial returns. While the underlying purpose of the National Forests is in no sense a financial one, and while the general public benefits resulting from the Forests would in themselves justify every cent that it costs to maintain them, nevertheless they already are producing a very substantial revenue and it should be possible in the not distant future to cover not only the costs of administration and protection, but also the costs of improvements, betterments, and other expenses incidental to this constructive forest enterprise.

At present the receipts from the National Forests are approximately three-fourths of what it costs to protect them and carry on the current business. It will be necessary to increase the earnings about \$1,000,000 a year to cover the cost of actual operation. In addition to this cost, however, there are expenses which are primarily in the nature of investments. These comprise expenditures for the construction of roads, trails, telephone lines, and similar improvements, the extensive planting of trees to reestablish forests which have been destroyed in the past by fires, the carrying on of research and experiments to aid in the development of the best methods of forestry, and expenses connected with the classification and segregation of agricultural lands within the Forests, the establishment of the permanent boundaries, and the making of homestead and other surveys. All expenses connected with the National Forests, including these investment expenses as well as the cost of operation, approximate \$5,275,000.

INCREASED RETURNS IN PROSPECT.

A fairly steady increase in receipts may confidently be expected. This will be derived chiefly from the two principal income-producing resources—timber and grazing. It may not be possible to secure as large an advance in receipts from timber sales during the coming year as occurred during the year ended June 30, 1916. That very large increase was somewhat abnormal. Each of the two preceding years had shown a decline in timber receipts, and the total for 1916 was only about \$71,000 above that for 1913. For some years the lumber industry of the country has been in a depressed condition, and while there was some improvement in 1916, which was reflected in the receipts of the year, this improvement has not yet enabled the Service greatly to extend its permanent business. The

improved situation did not bring any increase in the sale contracts of the year, which on the contrary fell off, but accelerated somewhat the rate of cutting under old contracts.

In the first years of administration of the National Forests by the Forest Service timber receipts mounted rapidly. A period of prosperity and activity in the lumber industry coincided with the opening of the Forests to general use through the energetic development and application of forestry methods. The panic of 1907 completely altered the situation. Vast quantities of private timber are now on the market and stumpage prices have been declining, with the prospect of extensive forced liquidation. In consequence the lumber industry is in an unstable and unhealthy condition. This situation naturally affects the demand for Government timber. There is a healthy and increasing local demand for timber needed in the development of the country, which is being taken care of through sales at an equitable price. Business of this character is growing and bound to continue to grow steadily. Sales for the general market, on the other hand, will fluctuate with the prevailing conditions. In general, however, there will be an increasing total of receipts from timber sales each year.

With the normal expansion of sales which the demands of a developing country will bring, timber thus will contribute its fair share toward repaying the cost of administering the Forests. Other forms of use also will increasingly contribute to this result. Recreational use is bringing a demand for summer home sites which, though still at an early stage, already has begun to swell the revenue from special-use occupancy to a marked degree. The income from rental of water-power sites is adding its quota. With completion of the water-power developments already under way, to say nothing of new projects, the receipts fund will gain materially unless existing laws are modified. Administration of National Forest water-power sites is logically an integral part of Forest Service administration of the lands embracing these sites, and a reasonable return to the public for their use is no more than fair and just.

GRAZING FEES.

The returns from grazing will rise as more stock use the Forests in consequence of range improvement and the development of new ranges. There is now in contemplation an increase in the grazing fee which would result in a marked further addition to the receipts fund. When regulation of grazing on the National Forests began a low scale of charges was adopted. This was necessary at the outset, both to prevent undue disturbance to the live-stock industry, which has been accustomed to using the ranges free of charge, and to facilitate the working out of a system of control which would secure the best use of the range and restoration of its productiveness. During the past 10 years of grazing regulation the value of the range to the stockmen has materially increased. Improved methods of managing both the range and the stock have been introduced. Losses are fewer, production is greater, and the product is of a higher quality. At the same time the outside public range has been greatly reduced, while the demand has grown.

Although there have been some readjustments of grazing charges, there has been no general advance in the rates. Present users of

the National Forest ranges are paying much less than the prevailing local rates on private, State, and Indian lands. This may be illustrated by some typical examples. In Montana lands of the Northern Pacific Railroad leased for sheep grazing bring the equivalent of 25 cents per head, as against a charge of 5 cents on adjoining National Forest lands. On the Crow Indian Reservation, in the same State, competitive bids realized 81 cents for sheep, while cattle grazers bid \$3; on adjoining National Forests the sheep rate is 13½ cents and the cattle rate 54 cents. On the White Mountain and San Carlos Indian Reservations, in Arizona, cattle pay \$2.40, horses \$3, and sheep 50 cents; on adjoining National Forest lands quite as good, cattle pay 48 cents, horses 60 cents, and sheep 12 cents. In California the Southern Pacific Railroad Co. obtains 5 cents per acre for land leased for sheep grazing, while similar and adjoining National Forest lands yield 1½ cents per acre.

The present demand for grazing privileges on a majority of the Forests far exceeds the carrying capacity, and the demand is on the increase. Under these conditions the stockmen using the National Forest ranges are enjoying special advantages over those who must pay for range on a competitive basis or do without. The value of ranches and stock is markedly increased, as is well recognized in current commercial transactions, by virtue of preference privileges to use of the Forest ranges. It is an established principle of National Forest administration that the man who is accorded a privilege of exclusive use of land or material for commercial profit shall pay the public in proportion to the value of what he receives. This is just, both from the standpoint of the public as owners of the Forests and from the standpoint of other individuals over whom otherwise the holder of the privilege would be unduly favored. It has become plain that increase of the benefits derived by stockmen from National Forest administration without a commensurate increase in the charge for the grazing privilege has created a situation which calls for readjustment. The proposal under consideration involves a moderate annual advance for three years. Before final action is taken an opportunity will be given for all parties interested to be heard. If the plan is made effective it will be put in operation on March 1, 1917, and should eventually bring the grazing receipts to more than \$2,000,000 a year.

THE STABILITY OF THE FORESTS.

The National Forests are gaining in stability through the land classification work. This means not only the fixing of the external boundaries, but also the classification and segregation of those lands which are to be opened to entry under the Forest homestead act. It is important for the general public to know what lands are to be retained permanently by the Government, and what lands will be available for agricultural settlement. It is no less important from the standpoint of administration. The whole public Forest enterprise is based on the assumption of permanence. The application of the principles of forestry necessitates a long look ahead. All the work is conducted with a view to constructive development of the property and its constantly increasing usefulness. Every timber sale is made

with a view to future consequences which may not be realized for many years. The work of protection from fire is not only to prevent the destruction of standing timber, but to save young growth and encourage the natural reproduction on lands which have been injured by previous abuse. Many millions of trees are established each year by planting or sowing, which will not come to maturity for a very long time. A regulated system of grazing looks to the progressive upbuilding of the Forest range as well as its present use; and the investment of public funds in extensive improvements is predicated on the permanence of the Government enterprise and would be unjustified on any other basis. Hence it has been deemed of great importance to push the work of land classification with all vigor. It is under this policy that during the past year there have been segregated from the National Forests by elimination more than 8,000,000 acres which were found to be either of greater value if developed in connection with the agricultural resources or not suited for the purposes for which the Forests were set aside; and more than 1,100 individual tracts within the Forests were made available for entry under the Forest home-
stead act.

In direct line with the work of classifying the National Forests and thereby establishing permanent boundaries of the lands which are to remain in Government ownership, is the need for consolidating land ownership where Government and private lands are interlocked. Congress has recognized this need, and from time to time has granted authority to exchange lands with private owners where such an exchange would be advantageous to the Government through the resulting consolidation of holdings. During the last session of Congress authority was granted for an exchange of lands within three different National Forests, namely, the Florida, the Oregon, and the Whitman. Under the same policy exchanges have been or are being negotiated with South Dakota, Montana, Idaho, and Washington for the school sections in the National Forests. The consummation of three of these State exchanges now awaits final approval by Congress.

At its last session Congress enacted two constructive measures which have a great importance and a far-reaching significance in relation to the permanence of the Forests. These were the appropriation of \$10,000,000 for the construction of roads within the National Forests and the appropriation of \$3,000,000 to extend the National Forests in the eastern mountains by purchase.

The appropriation for the construction of roads will permit the opening up of regions heretofore inaccessible, will greatly increase the use of the resources in the Forests, will shorten routes of travel across the States and between communities, will stimulate prospecting and mining in mineral regions, and in a multitude of ways will aid community upbuilding. The direct service of the roads in the work of fire protection and in increasing the returns from the Forests, both in general public benefit and in direct receipts, will be very great. Under the terms of the law, the cost of the roads will be returned to the Government from a portion of the National Forest receipts, as these may accrue. It is therefore an advance on future receipts. This action is in direct line with the policy of placing the National Forest enterprise on a permanent and stable basis of sound public business.

The importance of having public forests at the headwaters of important streams has been recognized and greatly emphasized through the appropriation of \$3,000,000 for continued purchases of forest lands, begun under the so-called Weeks Law. The work of establishing these new Forests has been started under most favorable auspices, and its discontinuance would have been peculiarly unfortunate. With the new appropriation the purchases may now go forward with a view to blocking out and extending the various units.

AREA AND ORGANIZATION CHANGES.

Presidential proclamations and Executive orders excluded from the National Forests last year 8,534,061 acres of land and added 116,916 acres. There were within the National Forest boundaries on June 30, 1916, 176,088,608 acres, including 20,668,328 acres of alienated land. The net National Forest area, or, in other words, the area actually owned by the public, was at the close of the year 155,420,280 acres.

A portion of the Paulina Forest in Oregon was eliminated, and the remainder was divided between the Deschutes, the Fremont, and the Crater Forests, and the Kansas National Forest was abolished. By an Executive order effective July 1, 1916, the Bonneville and Washakie Forests, Wyoming, were combined under the latter name. In consequence of these changes the number of the National Forests at the beginning of the new year was 152, as against 155 on July 1, 1915.

CLAIMS, ALIENATIONS, AND LAND CLASSIFICATION.

Through the patenting of claims 1,491 tracts passed to private ownership during the year, as against 881 in 1915. The greatest increase was in the patenting of homesteads, which numbered 761, as against 360 in 1915. Patents were issued for 703 mineral claims, 8 timber and stone claims, 2 coal claims, 4 desert claims, and 13 miscellaneous entries. The timber and stone claims and the desert claims represent filings recorded before the lands were withdrawn for National Forest purposes.

The work of classifying and opening to homestead entry such lands in the National Forests as are chiefly valuable for agriculture is progressing rapidly. This work is meeting with general approval. The results gathered under the special fund appropriated for this purpose are now becoming available. The reports and maps covering the areas examined by parties of land examiners are being rapidly completed and forwarded for final action. Already over 70,000,000 acres have been covered by field examinations and the final reports acted upon. In a considerable number of classification projects it early became evident that after the lands suitable for farm purposes had been segregated the remaining lands would not make practical units for administration. In such cases the matter was promptly settled by closing the classification project and eliminating the entire area.

Since the passage in 1912 of the act providing funds for land classification, and as a direct result of classification work, a total of 13,477,781 acres has been eliminated from the National Forests. This includes an elimination of approximately 5,800,000 acres of land

from the Chugach National Forest, Alaska, which embraced lands of low value for any purpose other than mining.

A very large part of the agricultural lands in the Forests already has been eliminated. The effect appears in the year's record of individual applications for Forest homesteads. During 1915, 4,433 applications for Forest homesteads were received in the seven districts. In 1916 the number was 2,589, a drop of 41 per cent. The number of tracts listed was 1,102.

FOREST MANAGEMENT.

The total amount of timber cut from the Forests in 1916 was 664,920,000 board feet, as against 669,676,000 board feet in 1915. Continuing unstable conditions in the lumber industry tended to restrain operators for the general market from undertaking further contract obligations for large quantities of timber. In consequence, the volume of timber placed under contract during 1916 was less than in preceding fiscal years. While a much smaller volume of timber was contracted for in large sales, a larger number of medium-sized sales was made. A slight increase in the total number of commercial sales indicates the widening field of service for National Forest timber. Ninety-seven per cent of all sales made during the year were under \$100 in value, indicating the extent to which the homesteader, rancher, miner, small mill-man, and others in need of a limited quantity of timber draw upon the Forests. In all, 10,840 sales were made, of which 4,433 were at cost rates to homestead settlers and farmers entitled to this concession by act of Congress. While the number and total volume of sales at cost during the year was slightly less than in 1915, the actual cut from such sales exceeded that of the previous year.

Under free-use permits 97,708,000 board feet of timber was cut and without permit about 21,775,000 feet. It is estimated that the free-use privilege was exercised by 42,055 individuals.

An average price of \$2.01 per thousand board feet was received for timber placed under contract in commercial sales during the year, in contrast with that of \$2.48 per thousand board feet for 1915. As stated in previous reports, the average price in sales for the year is no indication of the average market value of National Forest timber, but varies according to the location and character of the sales made. The average price for 1915 was raised by large sales of one of the more valuable commercial species in eastern Oregon.

TIMBER SALES BUSINESS OF THE YEAR.

The quantity and value of timber sold and timber cut under commercial sales is given by States in Table 1. In compiling this table material of all kinds was converted into board feet, log scale.

TABLE 1.—*Timber sold and cut under commercial sales, fiscal year 1916.*

State.	Timber sold.		Timber cut.	
	Quantity.	Value.	Quantity.	Value.
	<i>Board feet.</i>		<i>Board feet.</i>	
Alaska.....	45,868,000	\$60,994.96	35,019,000	\$48,587.70
Arizona.....	57,875,000	158,892.59	44,548,000	105,590.18
Arkansas.....	15,969,000	55,916.36	12,172,000	39,399.14
California.....	151,964,000	306,540.25	55,251,000	119,921.05
Colorado.....	57,380,000	95,292.14	37,055,000	68,572.71
Florida.....	53,000	100.05	81,000	130.08
Georgia.....	43,000	40.69	43,000	40.69
Idaho.....	71,359,000	167,080.56	72,208,000	154,918.15
Michigan.....	58,000	147.26	353,000	1,007.34
Minnesota.....	7,755,000	23,175.26	5,323,000	17,271.15
Montana.....	94,552,000	203,004.27	42,585,000	89,697.03
Nevada.....	1,988,000	5,146.66	1,352,000	4,509.05
New Hampshire.....	678,000	2,887.25	266,000	1,010.00
New Mexico.....	29,540,000	78,855.89	17,508,000	43,005.55
North Carolina.....	1,197,000	769.79	1,145,000	653.00
Oregon.....	6,461,000	11,719.73	86,250,000	192,572.21
South Dakota.....	41,155,000	107,190.51	19,479,000	51,259.85
Tennessee.....	3,223,000	1,730.74	1,066,000	861.05
Utah.....	88,622,000	258,875.79	24,970,000	63,720.04
Virginia.....	1,138,000	940.76	1,355,000	1,427.96
Washington.....	203,479,000	233,056.32	48,003,000	64,915.25
Wyoming.....	3,232,000	5,535.07	19,935,000	49,071.86
Total, 1916.....	883,589,000	1,777,892.90	525,967,000	1,118,141.04
Total, 1915.....	1,069,578,000	2,650,098.58	546,508,000	1,165,268.43
Total sales, 1916:				
Commercial.....	883,589,000	1,777,892.90	525,967,000	1,118,141.04
Cost.....	23,317,000	17,249.85	19,470,000	14,495.85
Grand total.....	906,906,000	1,795,142.75	545,437,000	1,132,636.89

Twelve sales of naval stores, aggregating 132,419 cups and with a value of \$10,349.95, were made on the Florida Forest during the year. The return per thousand cups was \$78.16, as compared with \$29.96 in 1915. The increase is attributable mainly to the greater value for naval stores production of the timber involved as compared with that worked in 1915.

The number of commercial timber sales classified by value and the number of sales at cost are given in Table 2.

TABLE 2.—*Number of timber sales, classified according to amount of sale, and number of cost sales, fiscal year 1916.**

State.	\$100 or under.	\$101 to \$500.	\$501 to \$1,000.	\$1,001 to \$5,000.	Over \$5,000.	Total.	Sales at cost.
Alaska.....	344	4	4	13	—	365	—
Arizona.....	632	4	2	3	1	642	74
Arkansas.....	92	4	4	13	2	115	36
California.....	997	6	3	6	5	1,017	439
Colorado.....	1,144	25	6	20	2	1,197	398
Florida.....	5	—	—	—	—	5	—
Georgia.....	7	—	—	—	—	7	—
Idaho.....	1,700	18	12	27	8	1,765	979
Michigan.....	2	1	—	—	—	3	—
Minnesota.....	17	4	2	3	1	27	—
Montana.....	2,130	34	9	12	3	2,188	1,257
Nevada.....	254	3	—	—	—	257	74
New Hampshire.....	2	—	—	1	—	3	—
New Mexico.....	437	3	2	9	4	455	78
North Carolina.....	38	—	—	—	—	38	9
Oregon.....	589	3	—	3	—	595	406
South Dakota.....	469	5	2	9	6	491	222
Tennessee.....	33	—	—	—	—	33	—
Utah.....	943	7	1	—	2	953	211
Virginia.....	60	—	—	—	—	60	—
Washington.....	311	8	1	3	5	328	115
Wyoming.....	290	4	2	—	—	296	135
Total, 1916.....	10,496	133	50	122	39	10,840	4,433
Total, 1915.....	10,621	117	58	69	40	10,905	4,562

Table 3 gives by States the quantity and price of the cost sales and the quantity and price of the cut.

TABLE 3.—*Timber sold and cut at cost rates, fiscal year 1916.*

State.	Number of sales.	Timber sold.		Timber cut.	
		Quantity.	Price.	Quantity.	Price.
		<i>Board feet.</i>		<i>Board feet.</i>	
Arizona.....	74	165,000	\$151.65	124,000	\$121.64
Arkansas.....	36	141,000	106.13	75,000	57.26
California.....	439	2,429,000	1,428.07	2,101,000	1,282.96
Colorado.....	398	2,547,000	1,863.13	2,556,000	1,920.73
Idaho.....	979	5,373,000	4,011.63	4,471,000	3,387.27
Montana.....	1,257	6,172,000	4,993.68	4,664,000	3,846.42
Nevada.....	74	314,000	244.29	255,000	101.32
New Mexico.....	78	225,000	205.22	253,000	225.43
North Carolina.....	9	13,000	9.11	11,000	7.91
Oregon.....	406	1,973,000	1,205.89	1,907,000	1,147.91
South Dakota.....	222	1,672,000	1,409.48	1,417,000	1,164.44
Utah.....	211	785,000	579.24	874,000	663.18
Washington.....	115	611,000	338.70	184,000	114.53
Wyoming.....	135	897,000	703.63	578,000	454.85
Total, 1916.....	4,433	23,317,000	17,249.85	19,470,000	14,495.85
Total, 1915.....	4,562	24,011,000	17,606.30	19,246,000	14,179.96

The average price, that is, 74 cents per thousand feet board measure, was the same as in 1915 and was \$1.27 per thousand feet less than the average price obtained in commercial sales.

FREE USE.

The free-use business of the year under permit is shown in Table 4. An additional amount of 21,775,000 feet, valued at \$28,530.31, was given to 9,672 persons without permit. The handling of free use through the designation of specific portions of the Forests as free-use areas, from which those entitled to free use are allowed to remove specified material without the necessity for taking out permits but with a form of supervision which prevents abuse of the privilege and secures compliance with the limitations prescribed by law, was materially extended. In consequence, the free-use business of the year handled under permits was, as the table shows, much below that in 1915. The convenience of the public is greatly served, while at the same time the cost of administration is materially decreased, by avoidance of the necessity for issuing individual permits wherever the other method is practicable.

TABLE 4.—*Free-use permits, fiscal year 1916.*

State.	Number of permits.	Free-use timber cut.		State.	Number of permits.	Free-use timber cut.	
		Quantity.	Value.			Quantity.	Value.
		<i>Board feet.</i>				<i>Board feet.</i>	
Alaska.....	2	11,723,000	\$13,098.00	North Dakota.....	129	65,000	\$178.50
Arizona.....	949	1,224,000	8,650.83	Oklahoma.....	467	145,000	72.50
Arkansas.....	76	138,000	232.29	Oregon.....	1,933	7,663,000	8,423.39
California.....	2,797	7,711,000	14,108.63	South Dakota.....	1,269	5,224,000	6,026.42
Colorado.....	3,657	9,627,000	14,155.46	Tennessee.....	85	294,000	209.00
Florida.....	14	14,000	15.37	Utah.....	5,054	9,727,000	11,966.76
Idaho.....	8,245	20,969,000	33,202.51	Virginia.....	38	216,000	86.75
Michigan.....	24	88,000	45.00	Washington.....	586	1,918,000	2,110.49
Minnesota.....	13	329,000	2,881.00	Wyoming.....	1,696	7,382,000	8,400.02
Montana.....	2,930	8,861,000	16,986.94				
Nebraska.....	17	5,000	50.00	Total, 1916.....	32,383	97,708,000	156,184.77
Nevada.....	469	1,276,000	2,818.38	Total, 1915.....	40,040	123,259,000	206,597.13
New Mexico.....	1,928	4,479,000	12,403.90				

EXTENSION OF TIMBER ESTIMATES.

During the year 705,872 acres of National Forest timberlands were estimated and mapped on an intensive basis, and 1,093,006 on an extensive basis. In all, 20,815,798 acres of Forest lands have been estimated and mapped by intensive methods and 47,291,660 extensively. The collection of data for timber estimates and maps is an essential feature of timber sale administration preliminary to an appraisal and sale of the timber. Examinations are consequently conducted for the greater part on those areas which contain timber already applied for by prospective purchasers or which has promise of being in demand in the near future.

Terms of sale, including minimum stumpage prices for advertisement, were established for the timber on 17 large tracts, each containing from 43,000,000 board feet to 137,000,000 board feet. Sales of the timber from four of the tracts were consummated during the year and applications were of record for the timber on six of the remaining number.

TIMBER TRESPASS.

The receipts from timber trespass were \$37,712.51, considerably in excess of the receipts for the past two fiscal years. This is due to the recent settlement for damages in several important trespass cases which occurred a number of years ago in Wyoming and California.

TIMBER SETTLEMENT.

The receipts for timber cut in connection with the occupancy or use of National Forest lands were \$2,298.69, as compared with \$3,180.89 in 1915.

PROTECTION.

The number of fires suppressed during the calendar year 1915 was 6,324, as against 7,018 in 1914 and an average annual number of 4,759 during the past five years. These figures include the fires occurring on the Purchase Areas in the East, which were omitted from the tabulation given in the Report of the Forester for 1915. While more than the average number of fires occurred, the timbered area burned over was but 155,416 acres, or 30 per cent less than the average per year for the period 1911 to 1915, inclusive. With fires almost as numerous as in 1914, the total loss of \$353,389 was but 70 per cent as great, and the average loss per fire was \$60.41, as against an average loss of \$74.44 for the five-year period.

Of the total number of fires, 3,536, or 56 per cent, occurred in the three States of California, Idaho, and Oregon, which have within their borders about 32 per cent of the total National Forest area and 49 per cent of the aggregate timber stand. Of the fires in these States, 2,919, or 83 per cent, were extinguished before a loss of \$100 per fire had been incurred, including 1,225 fires brought under control before one-fourth of an acre had been burned over.

The total cost of fire fighting, in addition to the salaries of the regular Forest force, was \$212,436, as against \$688,997 in 1914 and an average of \$249,227 for the past five years, the average cost per fire in 1915 being \$38.37, or one-third less than the five-year average.

The fire situation this year was unusual. Throughout the West the season of danger opened late, but also continued late. In the Southwest, where the main danger is in the spring, the snowfall in the winter of 1915 was very heavy, and favorable early conditions resulted; but after the forests dried out the situation continued bad until the third week in July, when the summer rains began. Elsewhere in the West the 1915 snowfall was generally deficient. Throughout the Northwest and on the Pacific coast the early prospects were very unfavorable, but late spring and early summer rains prevented conditions from becoming especially serious until well along in the season. In the central Rocky Mountain region, in spite of a late start, the situation by the middle of July had reached a point which made possible on one of the Wyoming Forests the most dangerous fire recorded in that district. In Utah and southern Idaho the fire season was the longest ever experienced; two fires occurred in November for the first time. In the Montana and northern Idaho Forests the season was comparatively short but very severe. In Washington and Oregon the peak of the fire season, usually reached by the middle of August, did not come until well after the 1st of September. In California it was necessary to keep the Forests manned with protection forces for over five months, and the season was not closed until November 10. In the eastern Forests and Purchase Areas, where most of the fires occur in the winter and early spring, the first part of the calendar year 1916 was characterized by a period of unusual danger due to drought, and many fires had to be fought.

At the close of the fiscal year the fire situation was generally, as compared with the previous season, highly favorable throughout the West. While complete details regarding the fires of the summer of 1916 are not yet available and do not belong in this report, it may be said that, except in the Southwest, the season was one of light losses and relatively little danger, in marked and welcome contrast with the conditions confronted by the Forest Service for three successive previous years.

In fighting the 1915 fires it became necessary again to draw upon the available funds to an extent which involved seeking from Congress a deficiency appropriation. An item of \$57,300 carried by the urgent deficiency act relieved the emergency. In the previous year a deficiency appropriation of \$349,243 made good the heavy extra expenditures for fire protection in the bad summer of 1914. No deficiency appropriation at all would have had to be made last year had not the emergency funds made available in case of need by the agricultural appropriation act been reduced by dropping out one of the items carried in earlier acts. Experience has shown that the emergency fund of \$150,000, which was all that was available in 1916, is sufficient only under exceptional circumstances. In four out of the last six years the amount spent has exceeded this amount, while in the other two years it was but little less. The dropped item curtailed by \$100,000 the emergency funds as compared with the year before.

Table 5 classifies the total number of fires in 1915 according to areas burned over, losses, and causes:

TABLE 5.

Extent of fires and amount of damage.	Number of fires.	Per cent of total.	Causes of fires.	Number.	Per cent of total.
Under 0.25 acre.....	2,762	43.67	Railroads.....	560	8.86
Between 0.25 and 10 acres.....	1,788	28.27	Lightning.....	1,799	28.45
10 acres and over; damage under \$100.....	1,428	22.58	Incendiarism.....	682	10.78
10 acres and over; damage \$100 to \$1,000.....	278	4.40	Brush burning.....	704	11.13
10 acres and over; damage over \$1,000.....	68	1.08	Campers.....	1,141	18.04
			Lumbering.....	169	2.67
			Unknown.....	988	15.62
			Miscellaneous.....	281	4.45
Total.....	6,324	100.00	Total.....	6,324	100.00

As will be seen from Table 5, 72 per cent of the fires were extinguished before 10 acres had burned over, and 44 per cent were confined to areas of less than one-fourth of an acre. The number of fires threatening the National Forests and successfully confined to outside areas was 1,127.

The percentage of fires of known origin attributable to human agencies was 59, the slight increase over 1914 being directly traceable to campers, who caused 18.04 per cent of all fires in 1915, as against 15.61 per cent for the five-year period. This increase is accounted for by the vastly increased use of the Forests for recreation purposes. The fires caused by railroads were only 8.86 per cent of the total, as against 14.44 per cent for the five-year period.

Protection of the National Forests includes not only their protection against fire, but also the control of insect infestation and tree diseases. Both of these raise large and difficult technical problems of forest management, which are receiving careful attention. For the basic knowledge in the fields of entomology and plant pathology necessary to the working out of these problems the Bureaus of Entomology and Plant Industry are looked to as the sources of information. In general, control of insects and fungous growths is practicable under existing conditions on the National Forests only through the working out of methods of utilization which will secure the removal of infested or infected material in connection with sales and free use of timber. Stipulations planned to bring about improved sanitation of the forest growth are, where necessary, inserted in timber-sale contracts and special efforts are made to inaugurate sales on areas where a clean-up is important.

REFORESTATION.

The work of reforestation was somewhat curtailed during the last fiscal year on account of unfavorable weather conditions in certain portions of the West and on account of some losses in the forest nurseries. This reduced somewhat the total acreage reforested below the 14,000 contemplated in the annual planting plan. Altogether, 10,396 acres were reforested.

Aside from the planting projects conducted in the sand-hills region of Nebraska, the projects initiated for intensive investigative study,

and the projects related to a more complete reforestation of watersheds from which municipalities obtain their water supplies, the sites used were largely old burns. During the year projects were carried on in such burns in the Douglas-fir region of the Pacific Northwest, in the white-pine region of northern Idaho, and in the Douglas-fir and spruce regions of the central Rocky Mountains.

The average costs of planting and sowing for the year are fairly representative of the costs of these methods in western National Forest reforestation. The average planting cost was \$10.62 per acre and the cost of sowing \$4.45 per acre. The total number of trees planted was 6,146,637. The quantity of seed used for sowing, exclusive of that used in the nurseries, was 8,288.77 pounds. Western yellow pine, Douglas fir, western white pine, jack pine, and red pine were the most important species planted, comprising 87 per cent of the acreage planted.

The acreage planted and sowed, by States, is shown in Table 6.

TABLE 6.—*Planting and sowing by States.*

	Area planted.	Area sowed.	Total.		Area planted.	Area sowed.	Total.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>		<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Idaho.....	2,606.35	546.00	3,152.35	Utah.....	176.41		176.41
Colorado.....	945.17	1,000.00	1,941.17	New Mexico.....	74.81		74.81
Oregon.....	1,448.74		1,448.74	Michigan.....	57.21		57.21
Montana.....	983.74	79.20	1,062.94	Washington.....	43.08	2.00	45.08
South Dakota.....	1.00	933.00	934.00	Wyoming.....		43.00	43.00
Nebraska.....	816.33		816.33	Arizona.....	3.70		3.70
California.....	240.00		240.00	Total.....	7,593.14	2,803.20	10,396.34
Florida.....	2.00	200.00	202.00				
Minnesota.....	194.60		194.60				

There is given in Table 7 a list of the forest nurseries maintained by the Service, with their locations and stock on hand July 1, 1916, in seedlings and transplants. The stock on hand in the nurseries at the end of the fiscal year was somewhat larger than that at the close of the year 1916, due in large part to the increased production in the Lake States nurseries and to the Morton Nursery in Nebraska which was established pursuant to a provision in the appropriation act for 1915 in order to extend reforestation work in Nebraska. The latter nursery, designated previously as the Niobrara Nursery, was changed in title during the year to the Morton Nursery in honor of the Hon. J. Sterling Morton, former Secretary of Agriculture. The nursery previously known as the East Tawas Nursery in Michigan was designated the Beal Nursery in honor of Dr. Beal, professor of forestry in botany at the Michigan Agricultural College for 40 years and the first man to do planting work in that State. The nurseries used 3,688.25 pounds of coniferous seed and 33 pounds of hardwood seed. The average cost to produce the seedlings was \$2.63 per thousand, and to produce the transplants \$5.44 per thousand, decreases of \$1.62 per thousand and \$0.61 per thousand, respectively, from the 1915 costs.

TABLE 7.—*National Forest nurseries and stock on hand.*

Nursery.	Forest.	State.	Seedlings.	Transplants.	Total.
Beal.....	Michigan.....	Michigan.....	368,000	4,000	372,000
Beaver Creek.....	Wasatch.....	Utah.....	2,465,000	294,000	2,759,000
Bessey.....	Nebraska.....	Nebraska.....	4,306,000	1,931,900	6,237,900
Boulder.....	Helena.....	Montana.....	220,000	158,980	378,980
Cass Lake.....	Minnesota.....	Minnesota.....	1,240,000	112,250	1,352,250
Cottonwood.....	Wasatch.....	Utah.....	3,535,700	401,000	3,936,700
Fort Bayard.....	Gila.....	New Mexico.....	205,000	144,131	349,131
Gallinas.....	Santa Fe.....	do.....	155,000	64,000	219,000
Monument.....	Pike.....	Colorado.....	1,729,000	810,000	2,539,000
Morton.....	Nebraska.....	Nebraska.....	1,787,100	167,300	1,954,400
Pilgrim Creek.....	Shasta.....	California.....	330,000	239,000	569,000
Pocatello.....	Cache.....	Idaho.....	756,000	26,500	792,500
Savenac.....	Lolo.....	Montana.....	8,269,000	1,833,000	10,102,000
Wind River.....	Columbia.....	Washington.....	3,013,000	2,283,200	5,296,200
7 smaller nurseries.....			162,250	74,458	226,708
Total.....			28,531,050	8,553,719	37,084,769

The amount of tree seed collected and purchased is indicated in Table 8. Seed thus secured is used in the nurseries and on direct seeding projects. On account of favorable conditions for collection a larger quantity of seed was collected than in 1915, and at a reduced cost per pound.

TABLE 8.—*Tree seed collected and purchased.*

	Conifers.		Hardwoods.	
	Clean seed.	Average cost per pound.	Clean seed.	Average cost per pound.
Collected by the Forest Service:	<i>Pounds.</i>		<i>Pounds.</i>	
District 1.....	2,702.75	\$1.24	.....	.....
District 2.....	2,732.00	1.20	2.00	\$0.32
District 3.....	86.50	1.31	.....	.....
District 4.....	436.00	1.84	.....	.....
District 5.....	117.50	1.13	.....	.....
District 6.....	1,202.00	1.08	.....	.....
Total.....	7,276.75	1.24	2.00	.32
Native species purchased.....	384.25	1.70	15.00	.47
Exotic species purchased.....	11.88	.91	.31	11.68
Grand total.....	7,672.88	1.26	17.31	.65

FREE DISTRIBUTION OF PLANTING STOCK.

There were distributed to 770 settlers in the Kinkaid district of Nebraska, under the act of March 4, 1911, 84,800 coniferous trees and 46,400 hardwood trees, as against 112,110 trees distributed in 1915 to 746 settlers. Each settler upon receiving the stock is requested to report the progress it makes after planting, so that the Forest Service may be able to determine the benefits resulting from the distribution of the stock. Progress reports for the year were submitted by approximately 56 per cent of those who secured stock in 1915.

RANGE MANAGEMENT.

The National Forest ranges continue in strong demand. Good prices for beef and mutton tend to encourage the present permittees to enlarge their business and cause new men to apply for grazing preferences. In some of the National Forests the high price of both mutton and wool is tempting cattle owners to substitute sheep. On the other hand, in some of the Northwestern States, where the winter sheep ranges are being taken up by homesteaders, there is a tendency to replace sheep by cattle, which can more readily be winter-fed and cared for on the farms and pastures of their owners.

Weather conditions during the year were somewhat unusual. The summer and fall of 1915 were extremely dry and vegetation on the ranges cured up much earlier than usual. It was generally felt that stock would leave the National Forests much below the standard, both in weight and general condition. On the contrary, with few exceptions, not only were the animals fully as heavy as in past years, but the flesh was extremely hard and firm, so that the shrinkage due to trailing and driving and while en route to market was considerably less than usual. The winter, with the exception of New Mexico and Arizona in the extreme Southwest, was notable for its severity and the very heavy snows that fell all over the West, and spring was backward. Because of the dry season of 1915 the supply of hay in the vicinity of the National Forests was below normal. It was necessary to begin feeding stock much earlier than usual, and to continue late. In many localities the hay was wholly exhausted before the middle of March and the stockmen were forced to turn their animals out on the near-by ranges to take their chances. The result was a considerable loss of adult animals, and in some regions a heavy reduction in the calf and lamb crop.

Range conditions on June 30, 1916, were, with few exceptions, reasonably normal, the forage growth having been very satisfactory, although in many Forests the snow was still so deep that the stock reached the high mountain ranges from two to three weeks later than in average years.

PERMITS.

The number of grazing permits issued and the stock covered by these permits are shown in Table 9.

TABLE 9.—*Grazing permits issued and number of stock grazed under permit, fiscal year 1916.*

State.	Cattle, horses, and hogs.				Sheep and goats.		
	Permits issued.	Number of stock grazed.			Permits issued.	Number of stock grazed.	
		Cattle.	Horses.	Hogs.		Sheep.	Goats.
Arizona.....	1,519	286,252	7,764	484	129	366,902	3,030
Arkansas.....	4	69					
California.....	2,765	183,746	9,922	1,224	326	409,835	7,217
Colorado.....	3,568	317,801	10,189		554	902,146	979
Florida.....	22	482		56	4	450	
Georgia.....	55	302	26	44	1	7	
Idaho.....	3,547	158,513	12,962	154	785	1,703,519	
Michigan.....	17	34					
Minnesota.....	1	31					
Montana.....	2,445	147,053	16,115	38	439	840,789	650
New Hampshire.....	3	31					
Nebraska.....	56	11,063	905				
Nevada.....	493	81,161	5,462		103	482,397	
New Mexico.....	1,796	120,148	4,637	534	515	437,958	31,341
North Carolina.....	99	637	20	57	12	59	
North Dakota.....	13	338	127				
Oklahoma.....	48	3,826	213				
Oregon.....	2,188	124,350	10,507	100	500	764,150	45
South Dakota.....	634	17,769	2,960				
Tennessee.....	20	326	1		2	27	
Utah.....	6,948	171,525	11,293	262	1,420	872,155	
Virginia.....	162	1,461	24		14	63	
Washington.....	619	21,269	1,463		147	232,546	
West Virginia.....	4	16		15	2	34	
Wyoming.....	1,026	110,563	4,413		323	830,170	
Total, 1916.....	28,052	1,753,764	98,903	2,968	5,276	7,843,205	43,268
Total, 1915.....	25,641	1,627,321	96,933	2,792	4,969	7,232,276	51,409

This was an increase of 133,442 cattle and horses and 605,338 sheep and goats over the previous year, while 2,400 new permittees for cattle and horses and 292 for sheep and goats were taken care of. This increase of over 8 per cent for both classes of stock and nearly 9 per cent in the number of permittees was despite the fact that a major portion of the eliminations from the several Forests during the previous year consisted of lands which primarily were grazing areas. It is accounted for, first, by improved methods of handling the stock, especially the sheep; and secondly, by a more intimate knowledge of the forage on the ranges and their carrying capacity, due to the extension of the range reconnaissance work. The excellent results already brought about through these two activities warrant the further extension of the work by larger allotments for that purpose. The stockmen are anxious to apply the information available and there is urgent need of Forest officers to advise the stockmen and their herders as to the proper methods of handling their animals, as well as to extend the reconnaissance work over every grazing Forest.

There were issued 1,705 free grazing permits, allowing the grazing of 72,967 cattle, 2,048 horses, 549 hogs, 429,163 sheep, and 1,270 goats in exchange for the use by National Forest permittees of 2,957,142 acres of unfenced private lands within the Forests. This was a slight increase over the previous year in number of permits, amount of stock, and acreage. Of crossing permits there were issued 2,098, for 68,571 cattle, 598 horses, 260 hogs, 3,491,562 sheep, and 1,100 goats driven across the Forests and feeding in transit.

The receipts from grazing, \$1,202,304.61, show an increase of \$77,627.17 over 1915. A part of the increase came from a readjustment of grazing rates between cattle and sheep, which resulted in a slightly higher rate for cattle. The major portion, however, came from the increased numbers of stock grazed.

Cooperation between live-stock permittees and the Forest Service materially increased. At the end of the year there were 254 live-stock associations cooperating with the Forest Service, as against 202 one year previously. The increase was mainly due to the very satisfactory results secured through cooperation in the erection of range improvements and the enforcement of special rules authorized by the regulations. These rules cover the question of salting of live stock, the handling of the stock on the ranges, the grade and number of bulls to be used, and other matters of management.

FREE USE OF RANGE.

The number of live stock using the National Forest ranges free continues to increase. In some portions of the Forests, noticeably in the Sierra Nevada Mountains in California, the demand for range for work, pack, and riding animals of campers and tourists has become so great that it was necessary to set aside considerable areas for their use, from which all other live stock is excluded. The allowance of 10 head of milk, work, or saddle animals free to each settler naturally increases as the homesteaders in and adjacent to the Forests increase. A large number of live stock belonging to the various Indians residing in or adjacent to the National Forests is also grazed free. A large amount of Forest range, in most instances suitable for grazing, has been withdrawn from all kinds of grazing use to protect the sources of water supply for towns and cities in and near the Forests. Other areas have been set aside as game preserves or refuges upon which grazing is either prohibited or restricted. The areas devoted to the above-mentioned free-use purposes exceed 6,000,000 acres.

RANGE PROBLEMS IN THE APPALACHIAN REGION.

During the year grazing administration was put into effect upon nearly all of the eastern Purchase Areas on which the title to the lands has passed to the Federal Government. Practically the same grazing regulations and instructions are being enforced on these lands as on the far western Forests, and so far no complications or difficulties have developed. The ready compliance by stockmen and farmers in this region with the regulations of the department and the instructions of the Forest officers indicates that these regulations are not onerous or burdensome. While it will doubtless be necessary to restrict or entirely forbid grazing on some of the eastern Forests in order to protect young forest growth, it is still evident that the income from grazing will always be considerable, and that the opportunity to use the ranges for their live stock will be to the benefit of the near-by farmers.

DESTRUCTION OF PREDATORY ANIMALS.

The work of destruction of predatory animals is now in the hands of the Bureau of Biological Survey, the agricultural appropriation act for 1916 having made special provision for its conduct by that bureau. The employment by the Forest Service of special hunters and the detail of Forest officers for this work has thus entirely ceased. The Bureau of Biological Survey furnished, however, some Forest officers with traps, ammunition, and poison for the destruction of predatory animals in connection with their other duties. Good results already have been obtained by the Bureau of Biological Survey, and still better results may confidently be expected as representatives of that bureau become better acquainted with the conditions.

CLEARING RANGE OF RODENTS.

In the work of destroying prairie dogs, ground squirrels, and other range-destroying rodents the Bureau of Biological Survey treated some 751,000 acres, with excellent results. It is estimated that there still remain 3,000,000 acres infested with prairie dogs, ground squirrels, and gophers within the National Forests, which, if the appropriations are continued, should be completely cleaned up within a few years.

GAME PRESERVATION.

One of the very important resources within the National Forests is the wild life. The National Forests constitute the natural home of a very large part of the game and fish of the western mountains; and with the building up of the National Forests in the East, these public properties will play the same important rôle in game protection as in the West. The National Forests at present carry only an insignificant fraction of the game which could be supported upon them. In fact, in many sections the game has been exterminated almost entirely. This deplorable situation is due to the fact that the game is not administered and developed as other resources in the Forests, and this failure is due to the dual jurisdiction over the game which is now attempted.

At the present time the States assume the jurisdiction over the game and the responsibility of its protection, on the National Forests as well as elsewhere. The Forest Service cooperates with the States in carrying out the State laws for protection. The Forest rangers are, wherever the State so desires, appointed as State game wardens and do everything in their power to see that the game laws are observed on the Forests. This cooperative assistance of the Forest Service has been a very great help in carrying out protective laws; but mere observance of game laws does not meet the situation, any more than protection from fire would meet the problem of the constructive development and use of the timber resources of the Forests. Game administration means much more, for it looks to building up and maintaining a supply of wild life and providing for the utilization of its increase.

The continuance of wild life is very largely dependent on the manner in which the National Forests are administered. This is particularly the case where grazing animals such as deer and elk are con-

cerned, and where there is a problem of correlating the support of the game with the use of the Forest ranges for domestic stock. The Federal Government furnishes the forage for the game, which is under the control of the States.

One of the most complex problems resulting from this unfortunate dual jurisdiction is the protection and administration of the great elk herds in the Yellowstone region. Here there are involved the Yellowstone National Park, in which the game is wholly under Federal jurisdiction, and a number of National Forests, on which the game is regarded as under the authority of three States, each having game laws different from the others and established without any consideration of the problems of administering the resources of the Federal property. Several State game preserves have been superimposed on the National Forests, adding to the complexity of the situation. There is no underlying plan of administration applying to the elk herds as a whole. On about 2,000,000 acres of the National Forest lands in this region grazing by domestic stock is either entirely prohibited or greatly restricted to provide range for the elk. The Government is expending very considerable sums in connection with the Bureau of Biological Survey ranch, which raises hay to feed the elk in unusually severe winters. Thus the Federal Government is spending large sums to support elk herds over which it has no direct jurisdiction and which at the present time are not being efficiently administered, and probably are being reduced in numbers. This difficult situation is being studied by the Forest Service in cooperation with the Bureau of Biological Survey and the officers of the National Park Service. A thorough investigation of the facts has been made on the ground and is nearly completed. The purpose of this investigation is not merely to get the facts, but to lay the foundation for correlating the interests of the States and Federal Government in a way which will result in an administration of the elk in the Yellowstone region under a comprehensive plan. Such a plan of cooperation would result in large benefits, not only in securing a proper handling of the game, but also in increased direct returns to the States and local communities.

Similar difficulties due to the dual jurisdiction over game matters occur also in other parts of the National Forests. The Forest Service is endeavoring to forward the cooperative plan of administration in the various National Forest regions. It is believed, however, that effective results will not be secured until it is possible to segregate portions of the Forests as Federal game sanctuaries which will serve as centers for the breeding of wild life to restock the surrounding country. These sanctuaries can be so located and so administered that the administration of the game may be coordinated with the use of the Forest ranges for domestic stock. They will serve to build up an important resource and will not conflict with the development of other resources. Legislation looking to this end has been recommended and is pending.

USE OF THE FORESTS FOR WATER-POWER DEVELOPMENT.

Twenty new power projects began operation, as against 12 in 1915. This was an increase of $18\frac{1}{2}$ per cent. The estimated average output capacity at minimum discharge for the plants in operation decreased from 2,420 horsepower to 2,070 horsepower. Develop-

ment of relatively small projects is particularly in evidence in the Rocky Mountain States. A decrease of 356,603 horsepower in the estimated capacity of all projects under permit was due mainly to the elimination from the Dixie National Forest of the land upon which is located a project of very large capacity, and in lesser measure to revised estimates of capacity and to the revocation of some permits for failure to comply with the conditions prescribed.

An apparent decrease of 76,183 horsepower in the capacity of plants in operation was due to a change in classification of a permit covering four projects, of which two are in operation, one is under construction, and one is not yet started. These four projects are in this statement placed each in its proper class, but in the 1915 statement were counted as one.

In the amount of power under permit and in operation, California still leads.

Of transmission-line permits the number in effect at the end of the year was an increase of 13 over the number one year previously.

The 40 applications for power-project permits shown in Table 11 as received during the year included 8 from Alaska—a notable evidence of increased local interest in power development on the National Forest lands there.

Permits are classified according to the character of the works covered. Permits for transmission lines only are designated "transmission-line permits," while those which cover reservoirs, conduits, or power houses, irrespective of whether or not a transmission line is involved, are designated "power-project permits." Table 10 shows the amount of development authorized under both classes.

TABLE 10.—*Water power development under permit, fiscal year 1916.*

Classes of permits.	Transmission lines only.			Power projects (reservoirs, conduits, power houses).		Total number of permits.
	Number of permits.	Length in miles.		Number of permits.	Estimated average output at minimum discharge.	
		Within Forest boundaries.	On National Forest land.			
Permits in force at close fiscal year:						
Rental permits—						
Preliminary.....	0	0	0	21	66,974	21
Final.....	111	794.4	589.5	88	770,058	199
Free permits.....	10	132.0	105.0	80	67,925	90
Total.....	121	926.4	694.5	189	904,957	310
Construction completed at close fiscal year:						
Rental permits.....	104	729.4	545.8	68	258,396	172
Free permits.....	9	108.0	90.0	60	6,697	69
Total.....	113	837.4	635.8	128	265,093	241
Construction incomplete at close fiscal year:						
Rental permits.....	4	22.5	16.4	8	131,999	12
Free permits.....	0	0	0	7	1,275	7
Total.....	4	22.5	16.4	15	133,274	19
Construction not started:						
Rental permits.....	3	42.5	27.3	33	446,637	36
Free permits.....	1	24.0	15.0	13	59,953	14
Total.....	4	66.5	42.3	46	506,590	50

Applications for permits were received during the year as shown in Table 11.

TABLE 11.

For rental permits.	Trans- mission lines only.	Power projects (reservoirs, conduits, power houses).	Total.
Preliminary.....	0	17	17
Final.....	7	7	14
For free permits.....	0	16	16
Total.....	7	40	47

On February 13, 1915, the Senate passed a resolution calling upon the Secretary of Agriculture for information as to "the ownership and control of the water-power sites in the United States, showing what proportion of such water-power sites is in private ownership and by what companies and corporations such sites in private ownership are owned and controlled, what horsepower has been developed, and what proportion of it is owned and controlled by private companies and corporations, and any facts bearing upon the question as to the existence of a monopoly in the ownership and control of hydroelectric power in the United States."

The preparation of this material was assigned to the Forest Service. The report was prepared from data in the files of the Chief Engineer and his assistants, but a large amount of work was involved in gathering together, studying, and rearranging the pertinent information and in assuring its correctness through supplementary investigation and correspondence with power company officials.

The report was submitted in three parts; of which Part I contained the text of the report; Part II, the plates and tables concerning primary power, power generated, and financial statistics, detailed data of power developments in 1915, summary tables showing the concentration in control of this power, and maps of 14 of the public-land States showing the location of all power plants, main transmission systems, and National Forest areas; and Part III, data concerning the interrelations between public-service holding companies and the relation of these companies to certain banking corporations, diagrams showing the successive steps by which certain holding companies have established their control over operating companies, and charts indicating the relation through directors or principal officials of certain public utility holding companies with each other.

The report presented in far greater detail than has ever been attempted before an exhaustive analysis of the general power situation. It showed a marked concentration of definite and complete control of a large percentage of developed water power by a very few companies. Data presented regarding interrelationships through common directors and principal officers indicated a marked tendency toward association or community of interests, particularly between the principal holding companies. The movement toward concentration in commercial central stations of all the primary power

employed in the electrical industries and in manufactures was found in all sections of the United States, the rate of concentration during the period from 1902 to 1912 being highest in the South Atlantic States and the extent of concentration greatest in the Western States. A revised estimate of the potential water-power resources of the United States gave the amount on the minimum basis as 27,943,000 horsepower, and on the maximum 53,905,000. The National Forests were stated to contain almost one-third of the total potential resources of the United States and over 40 per cent of the estimated power resources of the Western States, while existing developments which utilize National Forest land have 42 per cent of the total developed water-power of the United States; and an additional 14 per cent either occupies public land or is dependent upon reservoirs on such land.

The preponderance of developed steam power was found in the Eastern States and the rate of increase in water-power development for public service use from 1912 to 1915, approximately three times as great as in steam power. Primary power installation from all sources and for all uses increased from 1902 to 1912 more than two and one-half times as rapidly in the 11 Western States as in the remainder of the United States, while the increase for primary electric power for the same period was 440 per cent for the Western States as against 226 per cent in the other States. The development per capita of the Western States in 1912 was two and one-half times as great as in other parts of the country.

The report showed a considerable overdevelopment in nearly all the power centers of the Western States, California, Oregon, and Washington in particular showing installations far in excess of maximum demands.

OTHER SPECIAL USES.

Permits for the occupancy of National Forest lands for various uses other than water power were issued during the year as follows: Pay permits, 2,672; free, 2,526. At the close of the year 8,420 pay and 10,869 free permits were in force.

Of these 19,289 permits 4,270 were for pastures and 2,118 for residence sites. These are the leading forms of occupancy in point of numbers and are generally paid for. Through occupancy permits the needs of the public for summer home sites within the Forests now are met adequately, since the law gives authority to the Service to issue term leases. Increasing use of the Forests for recreation is bringing a rapid development in the demand for such leases. The control which the Government possesses by virtue of the retention of title to the land itself makes it possible to prevent land speculation and monopoly of the most desirable localities by a small number of persons, and at the same time to insist on sanitary and other precautions in the interest of all users. The substitution of a system of "summer homesteading," as has been advocated in some quarters and embodied in proposed legislation, would be a disastrous step from the standpoint of the interests of the general public as well as from that of the maintenance of the integrity of the Forests.

ROADS, TRAILS, AND OTHER IMPROVEMENTS.

Two appropriations are available for the construction and maintenance of permanent improvements. The first amounts to \$400,000 carried in the regular appropriation bill, which is designed primarily for the construction and maintenance of improvements needed in the protection and administration of the Forests. In addition, Congress has appropriated 10 per cent of the receipts from the National Forests for the construction of roads and trails, with the purpose primarily of aiding in the general development of the local communities. This amounted for the fiscal year 1916 to \$278,216.56, and was materially increased through cooperative funds from the local communities. Most of the road building in the Forests has been from the second item, while the regular appropriation of \$400,000 has been used for the construction of trails, telephone lines, lookout structures, and other miscellaneous improvements. In addition to the work of maintenance of improvements already built, there have been constructed during the past year 227 miles of new roads, 1,975 miles of trails, 2,124 miles of telephone lines, 89 miles of fire lines, 81 lookout structures, 40 bridges, 222 miles of fences, 545 dwellings, barns, and other structures, 17 corrals, and 202 water improvements. Included in the above figures are 116 miles of road, 203 miles of trails, 74 miles of telephone lines, 19 miles of fire lines, 42 miles of fences, 14 bridges, 1 lookout structure, and 12 water improvements built with funds, materials, and labor contributed cooperatively by the Forest Service and communities, associations, and individuals.

The estimated value of all improvements on the National Forests at the close of the year, including improvements paid for from the annual appropriations for this specific purpose, the 10 per cent of the National Forest receipts contributed for building roads and trails for the benefit of the public, and cooperative contributions, was \$6,318,143. Works of communication and protection account for \$4,461,510, or 71 per cent of this amount. The total of roads within the Forests which have been constructed or improved by the Forest Service is now 2,795 miles, and of trails 24,225 miles.

The recent appropriation of \$10,000,000 for the construction of National Forest roads will enable roads to be built on a very much larger scale than hitherto has been possible, and will result in the rapid opening of forest regions at present practically inaccessible.

SCHOOL, ROAD, AND TRAIL MONEY FOR STATES FROM RECEIPTS FUND.

Under existing law, besides the 10 per cent of the receipts which is made available for expenditure by the Secretary of Agriculture in building roads and trails for the benefit of the public, another 25 per cent of the receipts is paid to the States by the Federal Government for the benefit of the county schools and roads. The amounts available under both the 10 per cent and the 25 per cent clauses of the law during the fiscal year 1916 and the amounts that will be available during the current year from the receipts of that fiscal year are shown in Table 12.

TABLE 12.—*Amounts available for States from Forest receipts.*

State.	School and road moneys paid to States, fiscal year 1916.	School and road moneys payable States, fiscal year 1917.	Road and trail moneys expendable by Secretary of Agriculture, fiscal year 1916.	Road and trail moneys expendable by Secretary of Agriculture, fiscal year 1917.
Alaska.....	\$11,165.75	\$15,023.31	\$4,466.30	\$6,009.32
Arizona.....	59,807.89	64,024.72	23,923.16	25,609.89
Arkansas.....	8,738.93	11,283.87	3,495.57	4,513.55
California.....	67,611.87	80,049.75	27,044.74	32,019.91
Colorado.....	59,218.60	63,995.06	23,687.44	25,598.03
Florida.....	2,336.77	3,799.02	934.71	1,519.61
Georgia.....	77.36	92.50	30.95	37.00
Idaho.....	75,651.15	87,395.79	30,260.46	34,958.32
Kansas.....	1,357.33	4.78	542.93	1.91
Michigan.....	198.37	252.55	79.35	101.02
Minnesota.....	1,971.60	5,761.04	788.64	2,304.41
Montana.....	79,589.78	89,851.72	31,835.91	35,940.69
Nebraska.....	1,401.15	1,636.76	560.46	654.70
Nevada.....	16,244.53	17,597.15	6,497.81	7,038.86
New Hampshire.....	137.09	481.85	54.83	192.74
New Mexico.....	31,786.46	35,511.33	12,714.58	14,204.53
North Carolina.....	401.41	446.04	160.48	178.42
North Dakota.....	81.83	79.06	32.73	31.62
Oklahoma.....	759.77	985.29	303.91	394.11
Oregon.....	49,675.83	77,029.23	19,870.33	30,811.69
Porto Rico.....	9.25	.....	3.70	.....
South Dakota.....	12,988.11	15,442.59	5,195.25	6,177.03
Tennessee.....	94.35	287.43	37.74	114.97
Utah.....	48,675.96	48,383.09	19,470.38	19,353.24
Virginia.....	282.47	1,037.28	112.99	414.91
Washington.....	37,445.56	37,204.90	14,978.23	14,881.96
West Virginia.....	1.91	58.22	.76	23.29
Wyoming.....	43,086.86	37,827.07	17,234.75	15,130.83
Total.....	610,797.75	695,541.40	244,319.10	278,216.56

The States of Arizona and New Mexico received additional shares of National Forest receipts for their school funds, on account of school lands included within National Forests, as follows: To Arizona, paid in the fiscal year 1916 from the receipts of 1915, \$28,966.46, and payable from the receipts of 1916, \$31,046.12; to New Mexico, paid in the fiscal year 1916 from the receipts of 1915, \$9,311.87, and payable from the receipts of 1916, \$10,329.

ACQUISITION OF LANDS.

On recommendation of the Forest Service, the National Forest Reservation Commission approved for purchase during the year under the act of March 1, 1911, 54,898 acres in the Southern Appalachians and White Mountains. The total approved and being acquired is now 1,329,487 acres, of which 706,974.50 acres have been acquired. On 143,247.67 acres condemnation proceedings are pending. The remainder awaits the completion of survey or title examination. These lands are being placed under administration and their resources developed as rapidly as they are acquired.

Continuation of the purchase policy was provided for by a new appropriation of \$3,000,000, expendable for this purpose during the fiscal years 1917 and 1918.

COOPERATION WITH STATES.

Protecting the forested watersheds of navigable streams from fire, under section 2 of the Weeks law, was continued as the most important and far-reaching piece of cooperation with the States. The appropriation for this work was \$100,000, the same as in the previous year. Twenty-one States are now receiving cooperation of this character, Texas having been added during the year. An allotment has been set aside for expenditure in Louisiana, where cooperation is expected to begin in the fall of 1916. Under the requirement of the law Federal expenditure in any State must at least be equaled by the State.

While the expenditures are reckoned on the fiscal-year basis, allotments to the States are made by the calendar year for the full fire season. This makes it possible for the States to know before the beginning of the season the amounts they are to receive for the full danger period, and so make their plans accordingly. As an aid to making allotments a budget is required of each State at the beginning of each year showing (1) the prospective State income and expenditures to be devoted to the various branches of fire-protection work, and (2) the similar total estimated expenditures of municipalities (towns, counties, etc.) and of associations of private timber owners. The maximum allotment to any State was \$8,000.

The allotments for the calendar year 1916 and expenditures, both Federal and State, for the fiscal year ended June 30, 1916, are shown in Table 13.

TABLE 13.

State.	Allotments, calendar year 1916.	Expenditures, fiscal year 1916.		State.	Allotments, calendar year 1916.	Expenditures, fiscal year 1916.	
		Federal.	State.			Federal.	State.
Maine.....	\$8,000	\$6,726.83	\$46,552.65	Michigan.....	\$4,500	\$1,134.00	\$41,840.27
New Hampshire..	6,500	6,231.50	34,900.20	Wisconsin.....	4,500	5,763.20	11,223.62
Vermont.....	3,000	2,518.93	3,643.08	Minnesota.....	8,000	9,290.56	40,016.12
Massachusetts....	2,500	3,750.50	19,033.27	South Dakota....	450	442.00	1,221.29
Connecticut.....	2,000	479.00	3,045.48	Montana.....	3,500	3,570.57	3,754.19
New York.....	8,000	8,242.17	93,085.63	Idaho.....	5,500	4,455.67	19,233.97
New Jersey.....	2,000	1,907.00	9,908.79	Washington.....	8,000	9,611.25	30,689.97
Maryland.....	2,000	1,973.00	2,255.38	Oregon.....	8,000	7,989.50	27,071.43
Virginia.....	2,000	1,604.32	2,244.56	Administration			
West Virginia....	4,500	4,363.67	8,180.96	and inspection.	5,500	5,652.29	.....
North Carolina..	2,000	958.00	1,779.89	Unallotted balance.....	1,050	.....	.....
Kentucky.....	4,000	3,813.00	6,100.75				
Louisiana.....	2,000	.....	.....				
Texas.....	2,500	3.50	1,421.71	Total.....	100,000	90,480.46	407,203.21

The expenditure of Federal funds is restricted as closely as practicable to the salaries of lookout watchmen and patrolmen. This greatly simplifies accounting, reduces to a minimum the Federal fiscal regulations which State officers must observe, and facilitates the checking of expenditures and the enforcement of uniform standards in the use of Federal allotments. Most important of all, however, it makes it possible to demonstrate the efficacy of a lookout and patrol system in States where the law does not at present provide for such work.

The most important objects of expenditures under the Weeks Law are (1) to promote forest-fire protection by States, municipalities, and

associations or private timber-land owners, and (2) to develop closer cooperation among various agencies engaged in protective work and weld more or less scattered efforts into an efficient, organized system. The policy in expending the small amount of money available is to provide first for the needs of States whose resources are limited or in which general and efficient fire protection has not yet been developed. Money is expended also through Federal participation in fire-protection work, where such participation, even on a limited scale, aids in cementing the activities of existing public and private agencies.

The first attempt to secure anything like accurate data on forest fires in the United States in a given year was undertaken. Thirty-seven States sent in returns which represented approximately 56 per cent of the forest area of the United States. With these as a basis it is estimated for the whole country that in the calendar year 1915 some 40,000 fires burned over about 6,000,000 acres, with a money loss in timber, young tree growth, and improvements of at least \$7,000,000. The tremendous additional loss from soil deterioration and floods can not be computed. It is believed that the loss in 1915 was considerably below normal, owing to favorable weather conditions.

Of very great significance in the extension of forestry throughout the country was the action by the legislatures of Virginia and Louisiana in making reasonably adequate appropriations for their forestry work. The Forest Service rendered assistance by sending a member, on request, to appear before the legislatures. Assistance in drafting bills and formulating forest policies also was extended, upon request of the States, to Georgia, Maryland, and New York. In cooperation with West Virginia and North Carolina assistance was given in the organization of associations of private timber owners to protect their lands from fire.

The publication of a classified compilation of the State laws dealing with forestry has been continued, and a scheme of distribution put into effect whereby it is now furnished regularly, as issued, to State forestry departments, forest schools, legislative reference bureaus, forestry associations, and similar bodies.

RESEARCH.

NATIONAL FOREST INVESTIGATIONS.

Investigative work on the National Forests followed in the main the same lines as in previous years, with possibly a slight decrease in reforestation experiments and greater emphasis upon fire protection and general economic studies.

The most efficient protection of the National Forests from fire calls for an accurate and scientific knowledge of all the factors that enter into the problem. A comprehensive study was undertaken to secure the basis for a more scientific method of distributing National Forest fire-protection funds. The aim is to find the degree of intensiveness in fire protection warranted by timber, forage, and watershed values, as modified by their susceptibility to damage by fire. The study covered also other phases of fire protection, such as the prediction of dangerous conditions and the best means of fire prevention, detection, and control.

Many of the National Forests include watersheds which supply large irrigation projects with water. Closely bound up with the protection of such watersheds is the erosion problem. Many streams carry such enormous quantities of silt that the storage capacity of reservoirs is impaired seriously within a relatively short time, while an expense is involved in keeping the diversion works free from an excess of this material. Closely connected with excessive erosion is rapid run-off. A study to determine in what way the administration of the National Forests can keep the destructive processes of erosion on these watersheds at a minimum showed the balance between stability and rapid erosion of slopes often to be so delicate that slight abuse may result in complete loss of the fertile top soil and permanent changes in the character of the vegetation. Preventive measures, such as the regulation of grazing, conservative cutting of timber, and prevention of cultivation of nonagricultural soils, were shown to be much more effective and less costly than remedial measures.

In the more strictly technical studies dealing with the reforestation problems on the National Forests and elsewhere, further progress has been made. The study of artificial methods of extracting the seed of lodgepole pine from its cones has been completed, and valuable data obtained on the effect of different temperatures on the opening of the cones and on the quality of the seed. Probably the most important single point established is that lodgepole pine seed is usually not affected by drying temperatures up to 150° F., and may, in fact, germinate better after such treatment than seed obtained by air-drying, provided the kiln is properly constructed to insure free ventilation.

The study to find a relation between germination of seed in the greenhouse and in the field has been practically brought to completion. The analysis of hundreds of greenhouse tests seems to show that in the greenhouse the rate and vigor of germination is affected mainly by the quality of the seed and not by its source, while in the field just the opposite is true.

Tests to show the effect of the source of seed on form and growth of trees indicate very clearly that with all species the seed grown in the locality where the trees are planted give, as a rule, better results than seed imported from another region.

Important advance was made in the studies of nursery practice. Experiments are establishing the optimum spacing for the development of the best and cheapest planting stock. Experiments in grading seedlings at the time of transplanting brought out the need of a radical revision of our grading standards. Present standards do not eliminate the seedlings most likely to succumb in the transplant beds.

Experiments were made to determine the amount of seed to sow in nursery beds and the depth to which the seed of sugar pine, western yellow pine, Jeffrey pine, Douglas fir, white fir, incense cedar, and bigtree could be most advantageously covered.

Studies of the comparative value of burlap and pine-needle mulching in the growing of western yellow pine, sugar pine, Jeffrey pine, Douglas fir, white fir, and incense cedar showed that burlap as a mulch for spring-sown seed beds is in most cases superior to pine

needles in securing quicker germination, larger number of plants per square foot and per pound of seed, and better root systems.

Two species—noble fir and amabilis fir—regarding whose behavior in the nursery little was known before were made a special subject of study at the Wind River Experiment Station.

A great many of the experiments concerned with the best methods and seasons for reforestation work were brought to conclusion. All confirm the conclusion previously reported that, in general, planting is much safer than direct seeding and usually less expensive. In the semiarid Southwest planting can now be carried on with reasonable assurance of success.

Of the more fundamental studies in which progress was made during the year, the studies of forest types deserve particular mention. These studies have an important bearing on practically all other forest problems, such as forest management, reforestation, fire protection, and even land classification. They provide a knowledge of the environment in which the forests grow and of the factors which particularly affect growth, reproduction, and susceptibility to fire and other dangers. Their ultimate object is the quantitative determination of the climatic and soil requirements of different forest types and other plants growing within the National Forests. Such investigations are now being conducted in practically all of the National Forest districts, but are receiving particular attention in the central Rocky Mountains.

A study of the conditions under which natural reproduction may be expected after cutting or fire in certain forest types, and also of those where artificial methods must be used to bring back the forest cover, received further attention during the year, particularly in the Douglas fir and western white-pine region of the Northwest and the western yellow pine of Arizona. In the Northwest the characteristic capacity of the Douglas fir and western white-pine seed to lie over in the duff and leaf litter for a number of years and sprout up after the forest is burned or cut off has been investigated further as one of the most important facts bearing upon the capacity of the forest to reproduce itself naturally after cutting or burning. In the western yellow pine of the Southwest the study brought out the facts that failure of natural reproduction is due not so much to lack of germination as to the heavy mortality of many young seedlings; that a combination of good seed crops with favorable climatic conditions is required; and that seedlings need the protection of older trees as secured with conservative cutting that leaves merchantable young trees as a basis for a future crop.

Another important phase of the reproduction study is that of protection from grazing. Very definite results were secured as to the extent and conditions under which grazing proves detrimental to the natural reproduction, and specific remedial measures were evolved. With the development of watering places and the construction of fences, making possible the shifting of stock at will, the system of range management can be further improved so as to coordinate more effectively the best interests of both silviculture and grazing.

The first series of permanent sample plots established for the purpose of studying yield and reproduction of western yellow pine and Douglas fir has come up for the first 5-year remeasurement. Although

5 or 10 years more must elapse before absolutely conclusive results may be obtained, yet even now the data on yield, mortality, and damage by various agencies secured by the remeasurement are the most reliable thus far obtained anywhere. The remeasurements will yield most reliable information of various kinds, obtainable in no other way.

Range reconnaissance was slightly increased; approximately 2,500,000 acres was examined and mapped by special parties, and 373,478 acres by local Forest officers, making a grand total to date of 11,184,050 acres. The maps and field data collected furnish the basis for range improvement and intensive range management. Investigations in seeding ranges to cultivated forage plants were continued on a limited scale. Further investigations in the natural revegetation of range concerned primarily the practical application of deferred and rotation grazing. At the Utah Experiment Station on the Manti Forest, the Jornada Range Reserve in New Mexico, and the Santa Rita Range Reserve in Arizona a system of deferred and rotation grazing was put into application in connection with range management on a large scale. The results secured on desert ranges of the Southwest and also by minor experimental tests throughout the National Forests confirm the belief that the principles of deferred grazing, as developed by previous experiments in the Northwest, are applicable throughout western range lands.

The work of collecting and identifying plants which make up the forage crop on National Forest ranges and the collection of field notes on the distribution, forage value, and life history of these plants was continued.

Minor observations were continued on the effect of grazing upon the reproduction of conifer forests, as was the study at the Utah Experiment Station of sheep and cattle grazing in aspen forests. An investigation of the method of handling goats on the goat ranges of the Southwest secured improved methods of handling the goats and established the desirability of a system of deferred grazing. Demonstration tests of improved methods of handling both range and stock were initiated.

Continued study was given the difficult subject of grazing management of alpine lands subject to erosion and floods. Minor investigations were initiated in California and on the Jornada Range Reserve to determine the effect of burning the range upon the subsequent production of forage.

In the handling of cattle studies were initiated at the Jornada Range Reserve to determine how far it is possible under range conditions of the Southwest to increase the calf crop, improve the grade of stock, and reduce the losses by a segregation of breeding stock from dry stock, by careful attention to the selection and number of bulls used, by systematic vaccination to prevent losses from black-leg, and by retaining selected animals for the breeding herd when sales are made. During the last half of the year similar work was started on the Santa Rita Range Reserve. Additional minor investigations in the handling of cattle were continued on the Lewis and Clark, Medicine Bow, and Inyo Forests.

A number of demonstration tests were continued to further the adoption by sheepmen of the bedding-out system of handling sheep.

The system was adopted in a number of new localities. Observations relating to the use of small coyote-proof inclosures and sheds in connection with range lambing were continued, as was the gathering of careful data regarding the carrying capacity of ranges. Perhaps the most difficult grazing problem on the National Forests at the present time is that of the determination of the actual and potential carrying capacities of different ranges. Already the investigations have materially aided the stocking of the ranges to full capacity without decrease in future productivity.

Observations and demonstration tests to work out practical methods of eliminating loss of stock from poisonous plants included the eradication of larkspur on the Stanislaus Forest in California, in cooperation with cattlemen. Cattle range of approximately 14,000 acres, containing about 67 acres of larkspur, was selected for a demonstration test. The larkspur was dug out at a cost of \$695. The average loss of cattle from poisoning on this range in previous years was 34 head. In 1915 the loss was 4 head. The net saving was valued at \$1,800. Similar tests on a smaller scale on the Sierra, Angeles, Lemhi, Durango, Gunnison, and San Isabel Forests showed equally promising results. It will probably be necessary to go over the areas a second time to take out the few remaining plants. Further work is under way to determine more definitely where this method is practicable. On the Ruby and Mono Forests in Nevada investigations in the elimination of loss of cattle from larkspur poisoning by first grazing the larkspur areas with sheep gave results less promising than those from digging out the larkspur. Different methods of cutting and digging the plants were tested at the Utah Experiment Station. Further observations were also made to determine the feasibility of preventing losses by fencing. In connection with all range investigations and grazing administration special effort was put forth to secure the collection of poisonous plants throughout the ranges and to determine the distribution and abundance of each species. This information is imperative to the most efficient minimizing of the losses of stock from poisoning.

Experimental observations were continued, especially at the Jornada Range Reserve, regarding the proper distribution of stock-watering places under different range conditions in order to secure maximum efficiency in the utilization of range. Additional data were collected, also, relative to methods and cost of water development.

OTHER INVESTIGATIONS.

THE STUDY OF THE LUMBER INDUSTRY.

A comprehensive study of the lumber industry was begun by the Forest Service early in 1914. The Bureau of Corporations and the Bureau of Foreign and Domestic Commerce joined in this survey, which aimed to analyze in a constructive way the conditions in the leading forest using industry in the United States, and to show their bearing both upon the health and stability of the industry and upon the conservation of the timber resources of the Nation.

The investigations conducted by the Forest Service have extended over the regions of the South and West, where the bulk of the remaining forests are located and lumber manufacture is now most active, and

11 of the Central States where the distribution of lumber is probably most highly developed and its varying phases and tendencies are to be seen most clearly. Other studies have dealt with the technical sides of utilization and marketing and the replacement of lumber by other structural materials.

The Forest Service has cooperated with the Bureau of Foreign and Domestic Commerce meanwhile in studies of the opportunities for marketing American lumber abroad; and with the Federal Trade Commission in a series of hearings for the presentation of data by the lumbermen themselves regarding the condition of their industry. The Service has been in close touch with the Federal Trade Commission in the development of the entire inquiry and in the consideration of its conclusions, with a view to making the study of as much value as possible to the commission in relation to business methods and forms of organization in this industry.

The results of this broad survey, which is practically completed, will be embodied in 10 bulletins dealing with such subjects as timber ownership and lumber production by important regions, the cost and methods of distributing lumber, the most effective use of material now wasted in manufacture or converted into products of little value, and the character of the public timber holdings, together with the methods of administering them and the economic service which they should render.

The investigation has brought out strikingly the bad effect of the wholesale turning over of public timber lands into private ownership under the laws applicable to the public domain before the National Forests were created. The conditions resulting from private ownership, with its inevitable speculation and high capitalization of private timber lands, and from the demands of private capital have turned one of the great natural economic assets of the country into an industrial burden. Its weight is now being felt in frequent overproduction of lumber, which demoralizes the industry and leads to wasteful use of the very resource acquired from the public. These conditions have been accentuated by the narrowing market for lumber in relation to other structural materials, which has come about through changes in the standards and requirements of the country.

Although difficult by reason of the upset conditions in the lumber industry, the need for conserving the forests of this country is just as manifest as ever. The public itself is concerned most vitally in the long run.

SILVICULTURAL AND DENDROLOGICAL STUDIES.

The future of the pine lands of the South Atlantic and Gulf States received particular attention. A general survey of the field preliminary to a more detailed study brought to notice the rapid growth of slash pine, the early age at which it can be tapped, and the vigor with which it takes possession of the ground formerly occupied by longleaf pine. The unusual characteristics of the tree, together with the fact that it can be grown naturally over large areas of the cut-over pine lands, indicates the probability that it will be an important factor in the southern forests of the future. Its chief drawback, as compared with the longleaf pine, is its greater susceptibility to fire in the early stages of its life.

All of the tree studies which have been under way for a number of years are now completed. A comprehensive study was begun of the eastern oaks.

The effect of destructive logging upon the permanent development and welfare of local communities and the part which the marketing of woodlot products plays in the agricultural settlement of a new region were made subjects of special study. Other studies of the problems encountered by farmers in connection with the marketing of woodlot products were continued through field work in Georgia and South Carolina. There is room and need for the extension of this work. Reports on marketing woodlot products, several of which have already been published by the State agencies concerned, were completed for Missouri, Ohio, Tennessee, Minnesota, Indiana, Kentucky, Michigan, and Wisconsin. Publications on "The Care and Improvement of the Woodlot," "Measuring and Marketing Woodlot Products," and "The Status and Value of the Farm Woodlot," were issued. The preliminary work in Indiana and Tennessee was followed up in cooperation with the county agents. Sample woodlots were established in several of the counties, and their owners and the county agents instructed in the best methods of taking care of them.

The economic survey of the farm woodlots in the eastern United States, which is being carried on in cooperation with the Office of Farm Management, was extended to the States of Pennsylvania, Connecticut, Vermont, South Carolina, North Carolina, Tennessee, and Indiana.

The permanent sample plots established in the Eastern States in 1905 and 1906 came up for the third remeasurement. Being older than the plots on the National Forests in the West, their remeasurement has secured more conclusive data as to their growth, yield, and other changes in the development of the stand.

A revised classification of the forests of the country was begun through a study of the available data on the distribution of the forest types. This is an important project in that it will furnish basic knowledge for use in other investigations and in working out forest management. A preliminary map of the principal timber regions of South America was prepared in connection with the Pan American Congress.

Publications on the "Spruces and Balsam Fir of the Rocky Mountains" and the "Pines of the Rocky Mountains" were issued. Range maps of 115 tree species were prepared for use in connection with different publications and 2,000 range notes were collected.

Approximately 25,000 basket willow cuttings were distributed during the spring. Of these, 7,700 were sent to schools and institutions; 1,200 to State foresters; and over 16,000 to individuals.

Eighteen form, 11 volume, and 15 miscellaneous tables were worked up from 9,923 tree measurements already on file.

STUDIES IN FOREST PRODUCTS.

Utilization of National Forest timber.—In forest products investigations bearing upon the utilization of National Forest timber a number of mill-scale and depreciation studies were made. Studies of market conditions, covering chiefly the amount of timber used, the extent to which National Forest material is supplying the demands, and the

reasons, if any, which are withholding National Forest timber from local markets, were continued in nearly all of the districts. Investigations are under way to ascertain the cause for brown stain in sugar, western yellow, and western white pine lumber, and to develop preventatives. Several National Forest species were found to be suitable for kraft paper of an excellent grade. Engelmann spruce was found suitable for sulphite pulp. A report was prepared, as the result of an extensive field study, on the possibilities of pulp and paper production in Alaska. Approximately 5,000 mechanical tests were made of National Forest species, and other tests were initiated to determine the possibility of utilizing the products secured through distillation of National Forest species in the flotation process of mineral reduction.

Forest Products Laboratory.—The growing value of the Forest Products Laboratory as a source for information and advice to the various wood-using industries and the general public was indicated by the receipt of approximately 18,000 inquiries for data on the properties and uses of American woods and by visits to the laboratory of approximately 4,000 persons, including representatives from eight foreign countries. Cooperative relations were maintained with a considerable number of individuals, companies, associations, States, and other Federal departments in various investigations and tests.

Investigations by the Forest Service of particular importance in the news-print situation were continued. Tests on 22 species to improve methods and to determine the suitability of various species for the ground-wood process, which supplies in part the material for news-print, have been reported previously. Engelmann spruce, found in large quantities on the National Forests, has been shown to be suitable for manufacture under the sulphite process, which supplies the other pulp constituent of news-print, and efforts are now under way to determine the feasibility of chipping and drying this wood for shipment to the mills of the Lake States, which have practically exhausted the local supply of spruce and are now largely dependent upon Canadian timber. These efforts are of great economic importance because of the possibility of retaining in the United States the news-print industry, which for the past few years has been moving rapidly to Canada.

One of the most important problems of the lumber industry has been an efficient utilization of low-grade material. Low grades are used in a large percentage of the wooden boxes now manufactured. The railroad companies of the United States are paying annually claims amounting to many millions of dollars because of damages to goods in shipment. Much of this damage can be prevented through properly constructed boxes. Tests conducted at the laboratory indicate for canned-food boxes an increase in strength of 300 per cent by the use of four additional nails in each end. The results of these tests are being adopted rapidly by manufacturers and canners.

In the kiln drying of lumber the most important developments of the year were the discovery of a method of piling which improves circulation, the perfection of a method for southern-pine lumber which permits drying in 39 hours from green to shipping weight with a loss of less than 1 per cent, and the perfection of a method for red gum, one of the most difficult and refractory woods to dry, which reduces ordinary commercial losses of approximately 15 per cent to

less than 1 per cent. These processes have been developed on a semicommercial scale. The drying of maple shoe lasts, of which a great number are used in the United States, has been difficult because of the size of the blocks from which they are manufactured. On a semicommercial scale the period required for drying has been reduced to 7 weeks from nearly 2 years without increased loss.

The dyeing principle of the Osage-orange wood was not used prior to the investigations conducted in the laboratory. The value of this material has been so conclusively shown that from \$750,000 to \$1,000,000 worth of the dye is now being manufactured annually in the United States and practically all from material which was formerly wasted.

Approximately 12 per cent of the volume of the tree is bark. Little use has been made of bark except as the source of tanning extract and for fuel, and for the latter purpose the value has been very low. Investigations conducted at the laboratory have resulted in the use of spent tanbark in the manufacture of asphalt shingles to the extent of 160 tons per week. The value of this bark has thereby been increased from 60 cents to \$2.50 per ton. This is one of a series of very promising investigations to use a material formerly wasted.

A new process has been developed on a semicommercial scale for the manufacture of kraft or wrapping paper, and the suitability of 13 National Forest species for its manufacture has been shown. In addition to improving the quality and increasing the strength, the process promises reduced costs of at least 10 to 15 per cent and increased yields of at least 5 per cent. Paper has been manufactured which exceeds in strength and appearance any which it has been possible to secure from American or foreign sources.

A very considerable number of promising methods and processes have now been developed on a semicommercial scale and their industrial application awaits only tests on a commercial scale. In this important phase of its investigations, the logical consummation of all primary investigations, the efforts of the laboratory are greatly handicapped through inadequate funds. This list includes the manufacture of kraft paper from a considerable number of species, including southern yellow pine, western yellow pine, Douglas fir, etc.; improved processes of kiln-drying southern pine, red gum, western larch, and other species; a process of purifying the sulphate turpentine secured in the manufacture of kraft pulp from longleaf pine; the use of sodium fluoride to prevent blue stain; and the manufacture of wallboard from spruce bark.

Other developments of importance as a result of the investigations of the laboratory during the year are the adoption by a number of lumber companies of the improved grading rules for southern pine structural timber, previously adopted by the Southern Pine Association; the development of similar rules in a preliminary form for Douglas fir structural timber; development of a method on a semicommercial scale for removing casehardening in kiln-dried lumber; studies which indicate precautions which should be used in the selection of timber to prevent decay in buildings; demonstration of the fact that staves treated with creosote may be used in silo construction without injury to stock; adoption by approximately 40 per cent of the plants in the United States of improved methods of hardwood distillation developed by the laboratory and demonstrated on

a commercial scale; and completion of the investigations of the fundamental processes in the manufacture of soda pulp.

The work of the laboratory has reached a point at which an increase of force and equipment is much needed for an adequate handling of important and urgent problems, especially those relating to the lumber and the pulp and paper industries.

INDUSTRIAL INVESTIGATIONS.

In cooperation with the Bureau of the Census and with the National Lumber Manufacturers' Association, respectively, statistics were collected showing the production of lumber in 1914 and the production of lumber, lath, and shingles in 1915. A preliminary report was published in April, 1916. The production of lumber in 1914, as reported by 27,506 active sawmills, amounted to 37,346,023,000 board feet, a decrease of approximately 2.5 per cent as compared with 1913. The production in 1915, based on preliminary figures, amounted to 37,013,294,000 board feet, though mills not accounted for may have cut enough to bring the total for the year to 38,000,000,000 board feet.

In cooperation with the American Wood Preservers' Association, a report was compiled showing the consumption of wood preservatives by the treating plants of the United States. This report, the most complete of its kind yet issued, showed the progress of wood preservation, the relative demand for different preservatives, amount of timber treated by species and classes of material, and quantity of imported and domestic creosote consumed. It also pointed out the sources of supply and indicated to consumers of forest products the economy possible through the use of treated material. Statistics were also obtained, in cooperation with the association, showing the purchase of railroad ties and telephone and telegraph poles during 1915.

The wood-waste exchange, established for the purpose of aiding wood-using establishments in the closer utilization of wood waste, developed rapidly during the year. The cooperators now number over 500, many of whom have reported successful purchases or sales of wood waste through the medium of the exchange.

Quarterly records of lumber prices for the important commercial woods were compiled. These data are useful in making timber appraisals and answering general correspondence regarding the values of the various grades of lumber in the different regions.

Records of current stumpage sales were kept, the data being obtained through correspondence with bona fide buyers and sellers of stumpage. Stumpage values are of especial value in connection with the sale of timber on the National Forests.

A report was prepared on American woods available for export containing information of use to American consuls and prospective foreign purchasers of American lumber. The report contains a list of approximately 700 firms which supplied the Forest Service with satisfactory data regarding the kinds of wood available for export, the form in which the product is exported, including dimensions of stock, and the ports from which shipment may be made.

Cooperation with other departments in the form of advice concerning the purchase and best use of wood was continued.

A directory of American sawmills was prepared and published in cooperation with the Bureau of Foreign and Domestic Commerce, Department of Commerce. The purpose of this directory is to furnish wood-consuming factories and the lumber trade with information as to where the different kinds of lumber may be purchased, what mills can furnish each kind, and what mills can supply a certain pattern of lumber, certain classes of structural timber, and other forest products.

MISCELLANEOUS.

Thirty-four new publications were issued. In all, 277,000 copies of Forest Service publications were distributed. The total number of books and pamphlets in the library was increased to 18,852; 934 new ones were added and 327 duplicates and out-of-date publications were eliminated. The field libraries maintained in the district and supervisors' offices and the Forest Products Laboratory contain 29,527 books and pamphlets—a slight decrease in the number on file last year, due to the transfer of some books from the custody of the library to that of the Solicitor of the department.

Members of the Forest Service delivered about 426 public addresses, mainly at expositions and in response to requests from educational institutions, associations of lumbermen, technical societies, and National Forest users.

Exhibits consisting of models, specimens, maps, drawings, transparencies, and bromide enlargements were made at the Panama-California International Exposition, San Diego, Cal.; the Tenth Dry Farming Exposition, Denver, Colo.; the Safety First Exposition at the New National Museum, Washington, D. C.; and later, on the Baltimore & Ohio Government Safety First special, which visited various points throughout the East; the Philadelphia Civic Exposition; the Harrisonburg, Va., Fair; the Grand Roanoke, Va., Fair; the Lynchburg, Va., Fair; and the Johnson County, Va., Fair. The exhibit at the Panama-Pacific International Exposition, San Francisco, was continued over from the preceding year. At this exposition 260 illustrated lectures were delivered and a series of motion pictures of an educational nature shown daily. At the Panama-California Exposition occasional lectures were given throughout the entire year. Lectures were also given at the Tenth Dry Farming Exposition and at the Safety First Exposition in the New National Museum. Forest Service representatives attended and demonstrated exhibits at all those named except the Philadelphia Civic Exposition.

More than 1,700 lantern slides were loaned to 386 persons engaged in educational work. Traveling exhibits of photographs, maps, drawings, and wood samples were loaned to 172 schools and libraries.

REPORT OF THE CHEMIST.

DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., October 14, 1916.

SIR: I submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1916.

Respectfully,

C. L. ALSBERG,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

There was marked advancement during the year in the work of the Bureau of Chemistry, both in the development of agricultural chemistry and the administration of the Federal food and drugs act. More than 50 scientific investigations were completed. The results have either been published or are in the process of publication. Among them may be mentioned the discovery of a new sugar, studies on the molds and bacteria found normally in foods or producing spoilage in them, investigations upon forage and ptomaine poisoning, upon the physiological action of coal-tar dyes, upon vitamins, upon saponins, and upon the proteins of peanut, of kafir, and other seeds.

A large number of cases involving violations of the food and drugs act have been sent to prosecution. The number of civil and criminal actions recommended, however is not a complete index of the success attained in securing protection for the consumer under this law. Manufacturers of foods and drugs, more and more, are showing a willingness to comply with the regulations and in many cases have improved their products so as to anticipate expected requirements. To such manufacturers the service and regulatory announcements have been of direct assistance. In these announcements manufacturers and others concerned with the operations of the food and drugs act obtain ample notice of the department's opinions with regard to various trade practices and through this, as well as through other channels, are notified promptly of all changes. These announcements are supplemented by publication of the results of investigations which have developed improved methods of producing foods and drugs. The producers and manufacturers of food products also have been assisted directly through practical demonstrations of better methods of preparing and conserving foodstuffs.

The development of methods for preventing avoidable waste and spoilage of food products and the devising of new and valuable by-products have had special attention with the object of relieving as

far as possible the prices paid by the consumer for finished products by the elimination of losses and waste.

Special emphasis has been given by those in charge of the regulatory work in the past year to the control of drug products and in safeguarding the public from food subject to spoilage or pollution. Such foods if contaminated or improperly handled are liable to produce infection or poisoning and thus constitute a serious menace to health. With the object, therefore, of making the food and drugs act a hygienic measure as well as a preventer of economic fraud, the bureau has given especial attention to the interstate traffic in unclean milk, spoiled eggs, polluted oysters, and spoiled canned goods.

The interruption of imports has made it particularly important to the health of the people to curb the traffic in spurious synthetic drugs, because exceptionally high prices have offered unusual temptation to the sophisticator. Rigid enforcement of the Sherley amendment aimed at the false and fraudulent labeling of medicines was continued as a measure necessary for health protection.

As is pointed out in the report, much of the success in enforcing the food and drugs act has been due to the effective cooperation developed between State food, drug, and dairy officials and the Federal regulatory force.

RESEARCH.

PLANT CHEMISTRY.—Investigation of the nitrogenous compounds of kafir, *Andropogon sorghum*, has shown that fully one-half of them are soluble in hot 70 per cent alcohol. The soluble nitrogen consists in great part of a new alcohol-soluble protein, the percentage composition of which has been determined. It contains the amino acids lysin and tryptophan, both indispensable to the nutrition of animals. These are not found in zein, the corresponding protein of maize. Now that this is known a rational attempt can be made to learn how kafir may be fed to make it no less valuable than maize.

The peanut, *Arachis hypogaea*, and two globulins which have been separated from it have been found to contain an abundance of di-amino nitrogen. This form of nitrogen is indispensable to the nutrition of animals and is contained in inadequate amounts in the common cereals from which most feeds are derived. Peanut press cake should, therefore, prove to be an easily accessible material to make such cereal feeds more efficient. In cooperation with the Bureau of Animal Industry it is planned to make a practical test of this matter.

From the jack bean, *Canavalia ensiformis*, two globulins and an albumen have been separated and studied.

The nitrogen distribution in cotton and tomato seed, cowpeas, corn, corn germ, and wheat has been determined.

Many analyses of forage plants of the arid and semiarid West were made for the Bureau of Plant Industry.

New saponins have been isolated from *Yucca angustifolia*, *Yucca radiosa*, *Yucca filamentosa*, and *Agave lecheguilla*. A comparison of the surface tension effect of a series of saponins with their haemolytic power failed to disclose any interrelation of the two properties of the saponins.

The glucoside in the leaves of upland cotton has been found to be quercimeritrin. The results of this work are in preparation for

publication. The volatile oil distilled from the flowers has proven attractive to the boll weevil.

The results of the study of cyanogenesis in the common grass, *Tridens flavus*, showing that during maceration cyanogen may disappear, have been published. This observation signifies that many of the physiological studies upon cyanogenesis need revision.

The study upon boron absorption by plants discussed in the report for the year 1915 has been published.

A phytochemical laboratory has been established. It will undertake chemical investigations of the proximate principles of those plants which are of especial importance in connection with the enforcement of the foods and drugs act.

CARBOHYDRATES.—A new sugar, the only heptose hitherto discovered in nature, *d*-manno-ketoheptose, has been separated from the avocado. The data are ready for publication. A large number of investigations upon the preparation, the mutarotation, and the rotatory power of sugars and sugar derivatives have been completed and prepared for publication. Some of the results were published during the year in the following papers: "The Acetyl Derivatives of the Sugars"; "The Isomeric Pentacetates of Glucosamine and Chondrosamine"; "The Isomeric Tetracetates of Xylose and Observations Regarding the Acetates of Melibiose, Trehalose, and Sucrose"; "A Fourth Crystalline Pentacetate of Xylose and Some Related Compounds"; "A Second Crystalline *d*-Fructose Pentacetate"; "Crystalline β -Methyl Fructoside and Its Tetracetates"; "The Preparation of Melibiose"; "Bromoacetyl Xylose and β -Triacetyl-methyl-xyloside."

Papers have been published upon the occurrence of sucrose in relatively large amounts in a new seedling grape and upon the occurrence of sucrose in grapes of American origin. Bulletin No. 335, entitled "Development of Sugar and Acid in Grapes During Ripening," has been issued.

FLORA OF FOODSTUFFS.—An investigation of the range of conditions under which organisms of the *Bacillus botulinus* group may cause sickness or death in human beings and in domestic animals has been started. It was found that a strain of this organism obtained from a food poisoning case produced a very powerful poison. In cooperation with the Bureau of Animal Industry this poison was shown to affect rabbits, donkeys, and horses very quickly, cats in some cases and not in others, and not to affect fowls.

Because the losses to individual packers of sardines from swelled cans may be as high as 30 per cent of the yearly pack, this form of spoilage has been studied in the hope that means for preventing this waste may be found. The organism causing spoilage very rapidly forms spores which are killed only at high temperatures. Therefore, aside from ordinary cleanliness, careful processing at high temperatures is necessary to prevent the subsequent swelling of cans. In the "red feed" within the stomachs of "belly-blown" sardines a gas-producing bacterium, pathogenic to guinea pigs, has been found. A spore-bearing, gas-producing anaerobe identical with that found in sardines was isolated from two different consignments of spoiled sweetened condensed milk. *B. mesentericus ruber* was found to be the cause of the rose-pink color of certain spoiled sweetened condensed milks.

A general comparative study of the mold flora of the foodstuffs subjected to inspection has been begun, carefully distinguishing accidental organisms present as resting spores and those active in producing changes in the substrata.

The study of the effect of storage on bottled waters has shown that *B. coli*, *B. typhosus*, and *B. dysenteriae* inoculated into bottled mineral waters do not multiply, except the first two, which, in some instances, increased slightly during the first two days of storage. This was followed by a decrease in numbers. In a water practically free from dissolved solids, *B. coli* persisted in greatly reduced numbers for more than six months. A yellow micrococcus, multiplying rapidly, was found to be due to air contamination. The manner in which commercially bottled water changes its flora in one to six months was studied in considerable detail. Bulletin No. 369, "Bacteria in Commercial Bottled Waters," was issued. The results of a comparison of bile with lactose bouillon for determining the presence of *B. coli* in water were also published.

The United States Public Health Service has been assisted by the Bureau of Chemistry in making sanitary surveys of oyster beds. The results of a study of the preparation for and the transportation to the market of oysters, of a comparative study of bacteriological methods for the examination of oysters, and of a comparative bacteriological examination of oyster-shell liquor and oyster meats have been prepared for publication.

In cooperation with the Bureau of Animal Industry a manuscript has been prepared showing that one member of the group of molds known as *Aspergillus niger* produces 10 times as much oxalic acid as others, without accompanying differences in structure.

It has been found that the common molds *Penicillium camemberti* and *Aspergillus niger* produce substances reacting with ferric chlorid like phenols, a matter of significance in detecting moldiness in foods. It has also been found that the so-called salicylic acid reaction of the Japanese distilled liquor, sake, is in reality due to an acid formed by the mold used to ferment the rice from which sake is distilled. Mold products of this type may be mistaken for preservatives such as salicylic acid.

An as yet undetermined species of ergot was discovered in caraway seed.

ANTI-NEURITIC SUBSTANCES.—A variety of synthetic compounds have been made and tested physiologically. Several have been found to possess anti-neuritic properties similar to natural "vitamines." In collaboration with the United States Public Health Service a crystalline anti-neuritic product was isolated from yeast and some evidence obtained regarding its identity. A study of the nutritive and medicinal value of cod liver oil and extracts thereof was begun. One paper has been published and three nearly completed.

CEREALS—FLOUR.—Studies have been made upon the grading of flour and upon the determination of grades of flour with especial reference to the bleaching of flour. It has been found that the particles of various sizes in flour differ in chemical composition and in baking qualities. The work on flour substitutes has been continued, and a report on the determination of moisture in bread has been made. Chemical studies have been made upon the changes that take place in the deterioration of oats and in the bleaching of inferior oats.

Studies upon rice milling by-products have been completed. Bulletin No. 330, "The Milling of Rice and Its Mechanical and Chemical Effect on the Grain," has been issued jointly with the Bureau of Plant Industry.

SPICES.—Studies have been made of pepper, mustard, celery, caraway, and poppy seed, savory and sage leaves, and saffron to determine their constants as a guide in regulatory work. The determination of oxalic acid in pepper and cinnamon has led to a revision of the statements in the literature on this subject. Gingerol, the pungent principle of ginger, an oily liquid boiling at 227° to 229° C. at 6 mm. pressure, and paradol, isolated from grains of paradise, have been studied.

FATS AND OILS.—In cooperation with the Bureau of Plant Industry a bulletin has been issued upon peanut oil. A paper has been issued upon American charlock oil.

DRUGS AND PHARMACOLOGY.—Papers have been published on "The Stability of Nitrous Ether" and on the "Periodides of Phenacetin, Methacetin, and Triphenin." The results of investigations upon the "Periodides of Antipyrin, Iodantipyrin, Pyramidon" have been completed for publication.

Studies upon the heavy metals that may contaminate foods have been continued and some of the results published under the title, "The Influence of Heavy Metals on the Intestines." Papers upon the action of citrate and its decomposition in the body and upon the elimination of malate have been prepared for publication. An article on the toxicity of a series of oil-soluble dyes in which it is shown that some of them are eliminated in the urine combined with glycuronic acid has been finished and will soon be published. As a by-product of the study of the toxicity of water-soluble dyes containing iodine in the molecule, a research upon the influence of iodine and sodium iodide on the circulation has been printed. It has been found that digitalis and adrenalin antagonize the toxic heart action of oil of chenopodium while caffeine is synergistic. The result of this investigation has been published.

INSECTICIDES AND FUNGICIDES.—A tree-banding material has been developed which has been used by the Bureau of Entomology in its gipsy moth campaign. It promises to prove superior to and cheaper than the materials now in use in this country.

The Federal Horticultural Board has been further assisted in the fumigation of cotton bales, and the process has been so improved that a large part of the hydrocyanic acid used is recovered. One of the largest plants is now operating by this method.

In cooperation with the Bureau of Plant Industry attempts are being made to so modify the formula for Bordeaux mixture as to render it more efficient while at the same time reducing the amount of copper therein.

A paper upon the reduction of As^{V} to As^{III} by cuprous chloride and the determination of arsenic by distillation as arsenic trichloride has been published while others upon "The Preparation and Properties of Lead Chlor-Arsenate—Artificial Mimetite" and "The Arsenates of Lead" are in press.

ANALYTICAL METHODS.—Methods for the estimation of volatile esters in citrus oils and extract, of alcohol in the presence of phenol,

of phenacetin and salol in admixture, of tartaric acid, and of raffinose by enzymatic hydrolysis, have been published.

The results of investigations upon the identification and determination of lactic acid in biological products, upon the separation of lithium from the other alkali metals, upon a study of the Kjeldahl method for determining nitrogen, upon the freezing point of milk as a means of detecting water, upon the detection of watered milk by means of simplified molecular concentration constants, upon the detection of ergot and molds in food and drug products, upon the determination of the quality of gelatin by the measurement of its mutarotation, and upon the quality of commercial litmus papers have been prepared for publication. A method has been devised for distinguishing between bottle fermented and artificially carbonated wines.

The collation of the mass of information upon methods of food and drug analysis accumulated by the bureau described in the report for 1915 has made great progress. Forty-five subjects were finished during the year, making 66 in all since the work was begun. Much of the work is more than compilation, since the aim is to present the bureau's collective experience during the past 15 years. This requires not merely the critical sifting of the bureau's records, together with a study of the literature, but also not infrequently independent research.

CONSERVATION OF FOODSTUFFS.

POULTRY—EGGS.—A precooling plant has been developed, cooled by ice, capable of chilling 15,000 pounds of eggs and poultry a week, costing, installed, approximately \$800. With ice at \$3 per ton it has been found in actual commercial use to effect a saving of at least \$22 per carload in handling and chilling. The project upon improving the methods of fleshing poultry for the market has been continued. The work upon the transportation of perishables has been facilitated by the improvement of the method of installing resistance thermometers in refrigerator cars so that the temperature of the interior of a considerable number of cars may be observed simultaneously. The results of the previous work on damage to eggs in transit are being seen plainly throughout the country in greatly lessened waste at destination. Reports for the metropolitan district of New York City indicate that 41,161 dozens arrived broken during the calendar year 1915, while approximately twice that number were broken on arrival during 1914. In the study of the cold storage of eggs particular attention has been paid to the devising of methods to prevent stored eggs from acquiring the so-called "storage taste." Bulletin No. 224, "A Study of the Preparation of Frozen and Dried Eggs in the Producing Section," has been issued.

An investigation has been made of the contents of the crop of fowls for the purpose of furnishing data to detect the feeding, as a makeweight, of excessive quantities of sand just before slaughtering.

FISH.—Demonstrations in the preparation of fresh shrimp for the market with cleanliness, suitable boiling in brine, and thorough cooling has been of material value to the shrimp shippers of the southern east coast in the conduct of their business.

Studies of fish transportation to prevent decay have been continued. Perhaps no other perishable food is shipped long distances with so little knowledge of what is required to insure arrival in good order. The work was begun in Florida and at the end of the shipping season transferred to the Pacific coast, where transcontinental hauls are under observation. A Yearbook article upon the fish industry was published. Many analyses of food fish have been made which show that the data now on record are inaccurate because as a rule they were made without consideration of the season when the fish were taken. The studies upon the chemical changes taking place in fish in freezer storage begun last year have been continued.

The investigation upon the improvement of the methods of canning sardines has been brought to a successful conclusion. The industry has very largely accepted the recommendations of the bureau. It has taken steps to see that only sound fish are packed by imposing upon itself an inspection service.

POTATOES.—A process has been perfected for the drying of surplus and cull potatoes with simple machinery for the purpose of utilizing these tubers now largely wasted in certain localities in years of overproduction. The product can be fed to animals or be used as a size or for the manufacture of gum, dextrin, or starch. Being dry, it can be stored indefinitely and transported more cheaply than the potato itself.

A simple practical method of ensiling potatoes without cooking or the use of pure cultures has been discovered. To the crushed raw potatoes is added a starter consisting of 1.5 to 4 per cent of ordinary corn meal. The loss from the resulting fermentation is negligible. Cattle and hogs eat the product freely. Extensive feeding experiments are planned for the coming year.

CITRUS AND OTHER FRUITS.—The development of a method for the manufacture of citrate of lime from lemons has been completed, while the development of a method for the manufacture of citric acid free from contamination by heavy metals is well advanced. The manufacture of lemon oil has been further studied and the determination of the seasonal variations of the oil and citric acid content of lemons has been practically completed for certain sections of California. A study of tangerines has shown that the green fruit has value as a source of citric acid and that the oil has commercial possibilities. The manufacture of marmalade stock has been undertaken. A fine orange vinegar has been manufactured on a small commercial scale which promises to find a market, though a limited one, because it costs more to produce than the usual product. The determination of the composition of California oranges with reference to season, climate, soil, location, and methods of cultivation has been completed and the results are being prepared for publication. The study of the composition of oranges from selected trees has been of great assistance to the Bureau of Plant Industry in studying bud variations for the purpose of making selections in propagation experiments. Similar studies upon grape fruit have been begun with the Bureau of Plant Industry for the purpose of standardizing and improving the varieties grown. A study to establish the range of variation in composition of mature Florida and California grapefruit has been undertaken to be carried through several seasons.

Improved methods for the preparation of jams and jellies have been devised and manufacturers have been assisted in improving their methods and utilizing their waste products. In connection with the States Relations Service, from time to time lectures and demonstrations have been given at meetings of State agents upon the methods of preparing jams, jellies, and preserves in the household.

MISCELLANEOUS.—A method has been developed, though not yet applied on a large scale, by which a pure cane sirup can be made which will not crystallize nor ferment. The studies upon the effect of the different manufacturing processes upon the composition of maple sirup and of sorghum sirup have been continued. A paper has been published upon the composition of tamarind sirup.

Beans produced in certain localities are not as highly esteemed as their otherwise excellent quality warrants, because when soaked they do not swell uniformly. It was found that a cuticular substance is especially abundant in the epidermis of the hilum of those beans which, when soaked, swell slowly. The oxalic acid content of a large variety of beans has been investigated.

An investigation of the sauerkraut industry has shown that while factory construction and management have largely followed German models, the climatic differences between this country and Germany have not been considered. Adequate temperature controls to diminish losses in waste liquor, kraut, and brine have not been provided.

TECHNOLOGICAL INVESTIGATIONS.

DUST EXPLOSIONS.—For the prevention of explosions in the threshing of grain an automatic fire extinguisher, a blower device, and a plan of wiring the machines have been devised in cooperation with the Office of Public Roads and the Bureau of Mines. They were described in a joint bulletin with the Office of Public Roads, Bulletin No. 379, and blue prints were furnished to all manufacturers of threshing machines in the United States by that office. Detailed information has also been sent to underwriters and to farmers' mutual insurance companies dealing in threshing-machine insurance. Plans were made jointly with the Office of Public Roads to demonstrate these devices in the field, with the assistance of the State experiment stations of Idaho, Oregon, and Washington. The States of New York and Pennsylvania have been assisted in the drafting of regulations designed to reduce the danger from dust explosions and fire in mills and elevators. With the assistance of the Bureau of Standards laboratory apparatus was constructed for the mechanical separation of dust into fractions of definite size and density. By means of specially designed apparatus the force developed by the explosion of various kinds of dust has been measured. Results of the investigation upon the inflammability of carbonaceous dusts and upon the inflammability of carbonaceous dusts in atmospheres of low oxygen tension have been prepared for publication. In cooperation with the State College of Pennsylvania, the study of explosions in attrition mills has been begun.

PAPER.—A test has been found to determine the strength of paper when wet, which is a most important consideration in preparing specifications for photographic blue and brown print, bag, and wrapping

papers. An instrument has been constructed for the measurement of the translucency of paper. Instructions for testing the folding endurance tester, with data on the accuracy of this machine, have been prepared for publication. Papers have been published upon a new colorimeter and upon the detection of faulty sizing in high-grade papers.

TANNING.—A manuscript has been prepared upon American sumac to aid the farmer in gathering this plant and to help supply the demand in the dyeing and tanning industry. It has been found that the best way to denature egg yolk for tanning is to add 2 per cent of birch tar oil. Power distillate may also be used.

NAVAL STORES.—The Board of Trade of Brunswick, Ga., adopted the glass standards of the rosin types. They are now practically universally recognized in the Union. Examination of samples of rosin, mostly the pale grades, representing nearly 6,000 barrels, showed 9 per cent to have been graded too low and 38 per cent too high. A method for defining and determining the grades of turpentine has been perfected. A rough survey was made east of the Mississippi to determine the extent of the adulteration of spirits of turpentine sold for technical purposes. Twenty-six per cent of the samples were found to be adulterated with mineral oil to the extent of from 3 to 100 per cent.

DEMONSTRATION.

In connection with its research and regulatory work the bureau has done much demonstration and educational work. This has during the past years grown to such an extent that it deserves separate notice. Some of it has already been mentioned, as, for example, that in connection with the canning of sardines, the manufacture of dried and frozen eggs, the refrigeration of perishables, the shipping of fresh shrimp, and of fresh fish. The work of the poultry and egg packing demonstration car has increased greatly in efficiency and results. During the year 101 towns in the State of Indiana were visited and 10,600 people came to the car.

An extensive demonstration campaign has been conducted on the proper methods of packing tomato products which supplements the effect of prosecutions in eliminating unfit products from the market. In cooperation with the States Relations Service assistance has been given to canning clubs, especially in Florida, in the preparation of jams, jellies, and preserves. Assistance has also been given to manufacturers of these products. Instruction has been given in the grading of naval stores. Unfortunately a sufficient number of glass standards is not yet available because the disturbed trade conditions make it impossible to secure the necessary glasses. The demonstration of improved methods of producing rosin and turpentine has been begun in a small way. It is soon to be made more extensive.

ENFORCEMENT OF FOOD AND DRUGS ACT.

DOMESTIC FOODS AND DRUGS.—Five hundred and seventy-seven recommendations for seizure and 787 recommendations for criminal prosecution were made through the office of the Solicitor to the De-

partment of Justice. The work with the Bureau of Standards to establish "tolerances and reasonable variations" under the net-weight amendment has progressed, that upon dairy products being completed. Among the 1,036 cases of all kinds terminated in the courts during the year were 198 alleging false and fraudulent labeling of medicines, in all of which save 5 the courts found for the Government. In 1 food case a sentence of imprisonment was imposed. A number of indictments for conspiracy were found, upon evidence obtained by the bureau, concerning the adulteration of olive oil, domestic traffic in refuse eggs, traffic in refuse eggs exported to England, and the sale of spurious synthetic drugs.

There were collected 4,483 official samples. These showed an increasing percentage of substantial violations, an index not of increased disregard of the law, but, as pointed out in the report last year, solely of greater discrimination in the selection of samples. In addition an increased number of informal samples, about 4,000, were taken, because these demand less labor and yet are adequate for the routine checking of staple products to gauge the effect of the bureau's action, and for general surveys preliminary to definite campaigns. The number of official samples analyzed by the field force is given in Table I. The use of the guaranty legend and serial number ceased very largely during the year.

TABLE I.—*Report of branch laboratories for year ended June 30, 1916.*

Laboratory.	Import samples, analyses.			Floor-inspection samples.	Interstate samples, analyses.			Miscellaneous samples.	Total samples analyzed.	Hearings held.	
	Legal.	Illegal.	Released without prejudice.		Legal.	Illegal.	Check analysis.			Personal.	By correspondence.
Central district:											
Chicago.....	154	277	47	2,612	421	574	174	246	1,893	232	133
Cincinnati.....	192	51	4	243	163	176	39	1,977	2,602	134	326
Minneapolis.....	30	19	5	122	201	187	0	1,190	1,632	56	62
New Orleans.....	35	112	30	1,213	82	127	10	208	604	146	65
St. Louis.....	5	12	1	240	1,737	740	23	1,744	4,262	375	140
Total.....	416	471	87	4,430	2,604	1,804	246	5,365	10,993	943	726
Eastern district:											
Boston.....	364	453	84	10,089	125	343	23	195	1,587	439	193
Buffalo.....	9	60	13	43	31	143	0	306	562	64	113
New York.....	4,146	2,994	1,161	31,786	102	333	2	161	8,899	1,224	2,221
Philadelphia.....	277	227	101	2,973	47	59	2	42	755	360	40
Porto Rico.....	189	596	108	3,264	9	94	0	1	997	491	121
Savannah.....	36	39	1	0	84	150	0	25	335	13	39
Washington.....	68	11	1	14	314	304	9	657	1,364	13	4
Total.....	5,089	4,380	1,469	48,169	712	1,426	36	1,387	14,499	2,604	2,731
Western district:											
Denver.....	17	6	18	59	60	68	9	102	280	4	25
Honolulu.....	93	207	8	2,807	1	2	0	42	353	217	0
San Francisco.....	703	938	113	14,398	176	162	23	865	2,980	918	251
Seattle.....	134	351	68	6,605	76	73	0	340	1,042	267	29
Total.....	947	1,502	207	23,869	313	305	32	1,349	4,655	1,406	305
Grand total.....	6,452	6,353	1,763	76,468	3,629	3,535	314	8,101	30,147	4,953	3,762

In the Service and Regulatory Announcements were published 52 opinions and 600 notices of judgment.

All the work on the certification of colors was concentrated in Washington. The laboratory at New York City was transferred to new and more commodious quarters in the United States Appraiser's Stores. The St. Paul laboratory was moved into the new Federal building in Minneapolis. The dairy laboratory was abolished and its work distributed among other laboratories of the bureau.

A separate office has been established to deal with cases of false and fraudulent labeling of medicines and mineral waters under the Sherley amendment to the food and drugs act. To this office are also referred such medical matters as may arise in connection with the work of the bureau. At the request of the Secretary an officer of the United States Public Health Service was detailed to take charge. In consequence this work has been carried on more expeditiously and efficiently than heretofore.

A very close inspection was maintained during the past year over the early shipments of oranges and grapefruit. In this campaign the bureau received the active help of the greater part of the citrus fruits producers. Comparatively few sweated, immature oranges or grapefruit were marketed. The better quality of the fruit is believed to have resulted in a steadier market, so that the producer as well as the consumer benefited.

The unusual demand for cotton lint by the munitions factories greatly increased the delinting of cotton seed. The cake and meal made from such delinted seed has usually less protein than that from undelinted seed. Many mills in labeling their product used the analyses of former years, thus misleading the consumer, who, as a rule, was unable to protect himself because of the rising market. With the assistance of State officials, the Bureau has taken action in many cases.

Based upon cooperative sanitary surveys of the waters over oyster beds in certain sections, described in the report for the last two years, the department, by appropriate notice, warned the producers against the shipment interstate of oysters from such sections during the fall, spring, and summer, when the oysters are not hibernating. In the case of particular regions warning of this nature had been issued some few seasons prior to last year. This warning had not been heeded in all cases. Last fall prosecutions were brought, with the result that all shipments from such condemned territory thereafter were stopped in the fall and spring.

Other forms of adulteration not already mentioned that received especial attention are: The substitution of mountain maple, *Acer spicatum*, for cramp bark, *Viburnum opulus*, the adulteration of oysters, scallops, and canned tomatoes with water, the substitution of colored starch paste for tomato sauce, the reprocessing of spoiled canned goods, the traffic in cull beans, in decomposed tomato products, in rancid olive oil, in wormy horse beans, the substitution of foreign fat for cacao butter in, and the addition of cacao shells to, cacao products, the adulteration of rice bran with rice hulls, the coloring of inferior macaroni and of plain noodles, the misbranding of domestic macaroni in simulation of imported goods, and the adulteration of oats with water or weed seeds.

COOPERATION WITH STATE OFFICIALS.—It is not possible to give a complete account of the assistance given State and municipal officials by the bureau, or of the assistance received by the bureau from them, because much of this cooperation is of an informal nature and because local officials do not always report to the bureau upon the value of the information received. However, such cooperation has been more effective than ever before owing to the manner in which the Office of State Cooperative Food and Drug Control, established in 1914, has conducted its work, described in a general way in the report of last year, and because of the greater amount of information it has distributed. Many conferences have been held with State officials, and they have been notified of the beginning and termination of court cases, of court decisions, of all public hearings held by the bureau. Twenty-three sets of information cards on methods of food and drug analysis have been issued to them and they have been furnished copies of analyses and inspection reports. A Manual of Procedure for the Guidance of State Health, Food, and Drug Officials has been compiled and forwarded to State officials for their information and guidance when endeavoring to use the Federal food and drugs act as outlined in section 5 of the act. A list of Federal and State Dairy, Food, Drug, and Feeding Stuffs Officials has been prepared and kept up to date for the information of these officials. A compilation of State food and drug laws and of State food inspection decisions has been begun. Twenty-three instances of seizure action instituted by State officials are known to the bureau. Other seizure actions under the Federal law, not reported to the bureau, were undoubtedly inaugurated by joint action of the State official and the local United States attorneys. One hundred and ninety-one official samples were collected by State officials in 19 States. Among the adulterated articles proceeded against under State laws or municipal ordinances upon information furnished by the bureau may be mentioned decomposed eggs, decomposed canned goods, decomposed fish and poultry, polluted or watered oysters, watered scallops, saponin-containing foods, liquors containing wood alcohol, misbranded nostrums, and spurious drugs. In a large number of instances information was given to the Health Department of New York City which led to condemnation of adulterated food not coming under the jurisdiction of the Federal act. Many of the State and municipal officials have reciprocated for information of this kind by furnishing to the bureau evidence of violations of the Federal law. Among the most notable instances are polluted or watered oysters, watered scallops, adulterated milk or cream, decayed eggs, decomposed canned goods, butter and fish, wood alcohol in liquors, cottonseed meals and other feeds below guarantee, adulterated oats, and misbranded nostrums. Some specific instances of effective cooperation with State and municipal officials have been mentioned above in connection with other phases of the bureau's work. Two other types follow:

Abnormal trade conditions fostered the production of spurious drugs in place of synthetic ones which are ordinarily imported, notably acetyl-salicylic acid and neosalvarsan. Though a number of shipments were seized, a number of individuals successfully prosecuted under the food and drugs act, and indictments returned under

the postal laws, the traffic could not wholly be suppressed by Federal action nor the goods in the hands of local dealers in many sections of the country destroyed. The situation was laid before State and municipal officials who instituted many prosecutions and seizures with the result that through this joint action this fraudulent traffic was broken up.

In cooperation with the food and drug commissioner of Texas, the cause of contamination of certain wells in Texas, the water of which is widely distributed, was determined. When the results were laid before the local authorities steps were taken to remedy the situation. Similar action has been taken in the case of other spas.

The cooperation in the sanitary control of the milk supply of small cities described in the report for last year has been extended in Illinois, Iowa, Missouri, Kansas, Nebraska, and in New England. It is proposed to repeat this work year after year, extending it each year to new territory. In some localities bad conditions were found, due in the main to insufficient cooling and careless handling. Perhaps the best result of this work has been that it stimulated some of the local authorities to take up similar work independently so that definite permanent improvement of the milk supply of a number of cities has resulted. The cooperative work on the control of the shipment of decomposed eggs described in the report of last year has been extended to cover much of the territory in which shipments originate so that eggs are now candled before shipment far more than formerly and the spoiled eggs destroyed or fed to poultry and stock. At the same time information given to local officials has helped them to curb local traffic in eggs rejected in candling.

The joint committee on definitions and standards has considered a large number of products. Based upon its recommendations the following food inspection decisions have been issued: No. 160, Gluten Products and "Diabetic" Food; No. 161, Maple Products; No. 162, Egg Noodles and Plain Noodles; No. 165, Cacao Products.

IMPORTATIONS.—The analyses and inspections made in the control of the importation of foods and drugs have been tabulated in Table I. Owing to the unusual trade conditions, while the quantity of imports has been reduced, the variety has not; and there has been such a variation in a single class of products that it has been found necessary to make a great many more examinations of a single importation than were formerly required. This situation is particularly reflected in the quality of the crude drugs and spices received. Prices have been unusually high and the temptation to offer spurious or adulterated articles correspondingly great. The quality of senna leaves, cinchona products, ipecac, and strophanthus was often poor and sometimes a completely spurious article has been offered. The inability to procure certain spices from the usual sources has resulted in the introduction from new sources of new types, some of which were adulterated or spurious. Especial difficulty was encountered with coriander, fennel, celery, anise, cumin, and Chinese and Indian mustard. The poisonous leaves of *Coriaria myrtifolia* were found in marjoram leaves, *Origanum marjorana*. Owing to the increase of the bureau force of microscopists the control of crude drugs and spices is becoming more effective. Worthy of special mention is the continuation of the exclusion from New England of spoiled Canadian milk and

cream. Especial attention has also been paid to decomposed tomato products, spoiled sardines, and wormy olives. Mineral waters have been frequently examined for pollution. Many misbranded medicines have been detained until the misbranding was corrected. Many shipments of low-grade alimentary pastes colored in simulation of high-grade products have been excluded.

COLLABORATION.

For other bureaus of the department 3,194 samples were analyzed. For other executive departments and Government establishments 789 were analyzed as shown in detail in Table II. The totals do not include samples that were analyzed by the field service of the bureau. These are included among the miscellaneous samples given in Table I.

TABLE II.—*Miscellaneous analyses for other branches of the Government.*

Department of State.....	1	Department of Commerce.....	26
Department of the Treasury.....	65	Department of Labor.....	1
Department of War.....	97	Government Printing Office.....	10
Department of Justice.....	3	The Panama Canal.....	90
Post Office Department.....	67	District of Columbia.....	72
Department of the Navy.....	352		
Department of the Interior.....	5	Total.....	789

Sixty-seven samples of fraudulent medicines sent through the mails have been analyzed for the Post Office Department. Assistance was also rendered at hearings and in court at trials.

Assistance was also given in the revision of the United States Pharmacopœia and in the revision of the official methods of analysis of the Association of Official Agricultural Chemists.

REPORT OF THE CHIEF OF THE BUREAU OF SOILS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 11, 1916.

SIR: I have the honor to transmit herewith a report covering the operations of the Bureau of Soils for the fiscal year ended June 30, 1916.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

SOIL SURVEY.

PROGRESS OF THE WORK.

During the fiscal year ended June 30, 1916, detailed soil survey work was carried on in 75 different areas, some of them being completed as projects during the year, others begun and partially completed. These areas were distributed over 32 States, the maximum number of areas or projects in any one State being 6. The total area covered was 38,671 square miles, or 24,749,440 acres. Reconnoissance soil survey work was carried on in two States, 8,334 square miles being covered. The total area covered by detailed soil surveys from the beginning of the work to June 30, 1916, amounts to 408,600 square miles, or 261,504,000 acres, while the area covered by reconnoissance soil surveys amounts to 484,312 square miles, or 309,959,680 acres.

The study of the relation of soils to crops has been in progress since the inception of the soil survey work. It has been carried on by the soil survey field men during the progress of the soil mapping, the data being obtained through such correlation of the soil with crop yields and character as they were able to make by observation. The results have been discussed in a general way in the several soil survey reports.

It was recognized from the beginning of the work that the preferences shown by plants for different soils should be used as guides and suggestions in soil utilization. The need of a more intensive study of this relation and a more thorough sifting of the results obtained was recognized several years ago, and work was started on such a study, selecting as the first project the soils on which truck crops are being grown in an intensive way. This work has been in progress for the last two years. The field work for the study of the trucking soils of certain typical areas in New Jersey was completed early in the year and the material was prepared for publication during the winter. During the rest of the field season work has been in progress in the vicinity of Norfolk, Va.

The work of classifying the lands of the National Forests was in progress in each of the 6 western forest districts during the year. Work was done in 8 States, about 20 projects and a great number of separate homestead applications being examined, mapped, and passed upon. This work is being done in cooperation with the Forest Service.

The Bureau of Soils is now cooperating with 19 States in the work of the soil survey. There are 6 additional States in which cooperation is planned for 1918, the final arrangements in each case being contingent on an appropriation by the legislature of funds to enable the State institution to cooperate.

In most of the States with which the survey cooperates the cooperating institution is the experiment station. In a few it is the geological survey and in a few others the State department of agriculture.

The following tables give in detail the essential facts concerning the areal work of the soil survey:

Individual areas surveyed and mapped in the fiscal year ended June 30, 1916.

DETAILED.

State.	Area.	Area surveyed.	
		Square miles.	Acres.
Alabama.....	Lowndes County.....	601	384,640
	Monroe County.....	753	481,920
	Pickens County.....	875	560,000
	Wilcox County.....	1,060	678,400
Arkansas.....	Craighead County.....	687	439,680
	Hempstead County.....	727	465,280
	Yell County.....	1,282	180,480
California.....	Anaheim area.....	520	332,800
	Healdsburg area.....	268	171,520
	Los Angeles area.....	490	313,600
Delaware.....	New Castle County.....	1,327	209,280
Florida.....	Hillsborough County.....	1,329	850,560
Georgia.....	Brooks County.....	514	328,960
	Crisp County.....	277	177,280
	Meriwether County.....	496	317,440
	Richmond County.....	319	204,160
	Wilkes County.....	1,291	186,240
Idaho.....	Latah County.....	1,488	312,320
Indiana.....	Grant County.....	412	263,680
	Starke County.....	308	197,120
	Wells County.....	1,208	133,120
	White County.....	1,344	220,160
Iowa.....	Clinton County.....	1,538	344,320
	Mitchell County.....	115	73,600
	Scott County.....	449	287,360
	Sioux County.....	1,502	321,280
	Van Buren County.....	1,354	226,560
Kansas.....	Cowley County.....	1,287	183,680
Kentucky.....	Jessamine County.....	1,72	46,080
Louisiana.....	Rapides Parish.....	1,932	596,480
Maine.....	Cumberland County.....	853	545,920
Michigan.....	Calhoun County.....	444	284,160
Mississippi.....	Hinds County.....	858	549,120
	Lee County.....	448	286,720
Missouri.....	Barry County.....	205	131,200
	Buchanan County.....	1,259	165,760
	Newton County.....	1,422	270,080
	Ripley County.....	624	399,360
	St. Francois County.....	458	293,120
	Texas County.....	108	69,120
Nebraska.....	Box Butte County.....	348	222,720
	Dawes County.....	1,085	694,400
	Dodge County.....	187	119,680
	Polk County.....	430	275,200
	Richardson County.....	1,247	158,080
	Washington County.....	1,209	133,760

¹ Does not include portions of the area surveyed in preceding years.

Individual areas surveyed and mapped in the fiscal year ended June 30, 1916—Continued.

DETAILED—Continued.

State.	Area.	Area surveyed.	
		Square miles.	Acres.
New Jersey.....	Camden area.....	1 155	99,200
New York.....	Cortland County.....	340	217,600
	Seoharie County.....	1 432	276,480
North Carolina.....	Alleghany County.....	209	133,760
	Anson County.....	1 470	300,800
	Davidson County.....	569	364,160
	Halifax County.....	468	299,520
	Harnett County.....	595	380,800
	Hertford County.....	341	218,240
North Dakota.....	Bottineau County.....	1 378	881,920
Ohio.....	Geauga County.....	412	263,680
	Hamilton County.....	1 283	181,120
	Lucas County.....	342	218,880
	Miami County.....	1 235	150,400
Oklahoma.....	Kay County.....	1 696	445,440
Pennsylvania.....	Blair County.....	1 457	292,480
	Cambria County.....	696	445,440
South Carolina.....	Berkeley County.....	1 238	792,320
	Richland County.....	1 310	198,400
Tennessee.....	Shelby County.....	801	512,640
Texas.....	Bell County.....	1 083	693,120
	Eastland County.....	925	592,000
	San Saba County.....	590	377,600
Vermont.....	Windsor County.....	1 605	387,200
Virginia.....	Fairfax and Alexandria Counties	1 341	218,240
Washington.....	Benton County.....	1 635	438,400
West Virginia.....	Gilmer and Lewis Counties.....	733	469,120
Wisconsin.....	Portage County.....	1 703	449,920
	Wood County.....	1 569	364,160
Total.....		38,671	24,749,440

RECONNOISSANCE.

California.....	Lower San Joaquin Valley.....	4,760	3,046,400
Wisconsin.....	South part of north central....	1 3,574	2,287,360
Total.....		8,334	5,333,760

¹ Does not include portions of the area surveyed in preceding years.

Total areas surveyed and mapped in the several States in the fiscal year ended June 30, 1916, and the areas previously reported.

DETAILED.

State.	Work during 1916 (square miles).	Work previously reported (square miles).	Total.	
			Square miles.	Acres
Alabama.....	3,289	38,633	41,922	26,830,080
Arizona.....		611	611	391,040
Arkansas.....	1,696	7,623	9,322	5,966,080
California.....	1,278	15,923	17,201	11,008,640
Colorado.....		2,809	2,809	1,797,760
Connecticut.....		1,704	1,704	1,090,560
Delaware.....		422	749	479,360
Florida.....	327	8,261	9,590	6,137,600
Georgia.....	1,329	8,261	9,590	6,137,600
Idaho.....	1,897	16,260	18,157	11,620,480
Illinois.....	488	1,703	2,191	1,402,240
Indiana.....		6,770	6,770	4,332,800
Iowa.....	1,272	8,138	9,410	6,022,400
Kansas.....	1,958	5,806	7,764	4,968,960
	287	8,729	9,016	5,770,240
Kentucky.....	72	3,169	3,241	2,074,240

Total areas surveyed and mapped in the several States in the fiscal year ended June 30, 1916, and the areas previously reported—Continued.

DETAILED—Continued.

State.	Work during 1916 (square miles).	Work previously reported (square miles).	Total.	
			Square miles.	Acres.
Louisiana.....	932	10,536	11,468	7,339,520
Maine.....	853	939	1,792	1,146,880
Maryland.....		4,581	4,581	2,931,840
Massachusetts.....		1,494	1,494	956,160
Michigan.....	444	5,015	5,459	3,493,760
Minnesota.....		4,285	4,285	2,742,400
Mississippi.....	1,306	17,859	19,165	12,265,600
Missouri.....	2,076	23,909	25,985	16,630,400
Montana.....		882	882	564,480
Nebraska.....	2,506	9,082	11,588	7,416,320
Nevada.....		235	235	150,400
New Hampshire.....		1,411	1,411	903,040
New Jersey.....	155	3,077	3,232	2,068,480
New Mexico.....		596	596	381,440
New York.....	772	14,474	15,246	9,757,440
North Carolina.....	2,652	21,168	23,820	15,244,800
North Dakota.....	1,378	10,129	11,507	7,364,480
Ohio.....	1,272	7,024	8,296	5,309,440
Oklahoma.....	696	4,275	4,971	3,181,440
Oregon.....		1,965	1,965	1,257,600
Pennsylvania.....	1,153	11,932	13,085	8,374,400
Porto Rico.....		330	330	211,200
Rhode Island.....		1,085	1,085	694,400
South Carolina.....	1,548	16,850	18,398	11,774,720
South Dakota.....		675	675	432,000
Tennessee.....	801	7,342	8,143	5,211,520
Texas.....	2,598	22,379	24,977	15,985,280
Utah.....		1,951	1,951	1,248,640
Vermont.....	605	367	972	622,080
Virginia.....	341	7,257	7,598	4,862,720
Washington.....	685	6,837	7,522	4,814,080
West Virginia.....	733	12,362	13,095	8,380,800
Wisconsin.....	1,272	10,753	12,025	7,696,000
Wyoming.....		309	309	197,760
Total.....	38,671	369,929	408,600	261,504,000

RECONNOISSANCE.

Alaska.....		31,768	31,768	20,331,520
Arkansas-Missouri.....		58,000	58,000	37,120,000
California.....	4,760	13,458	18,218	11,659,520
Kansas.....		39,960	39,960	25,574,400
Nebraska.....		53,064	53,064	33,960,960
North Dakota.....		39,240	39,240	25,113,600
Ohio.....		41,420	41,420	26,508,800
Pennsylvania.....		41,405	41,405	26,499,200
South Dakota.....		41,400	41,400	26,496,000
Texas.....		92,297	92,297	59,070,080
Washington.....		13,115	13,115	8,393,600
Wisconsin.....	3,574	10,851	14,425	9,212,000
Total.....	8,334	475,978	484,312	309,959,680

FERTILIZER INVESTIGATIONS.

This division came into being as a separate administrative unit on November 1, 1915. Prior to November 1, 1915, the work was under the direction of Dr. Frank K. Cameron; since that date Mr. Frederick W. Brown has been in charge.

The work of the division is divided along three lines which deal respectively with the three fertilizer ingredients—potash, nitrogen, and phosphates.

POTASH.

Through its representative on the Pacific Coast the bureau has kept in close touch with the development now going on in the industry of extracting potash from giant kelps. During the winter the various plants then building or in operation were visited and the processes being used or proposed for the recovery of potash from these sea plants studied so far as possible. In addition, laboratory experiments along the line of kelp distillation have been conducted.

In cooperation with the Bureau of Fisheries, plans have been made for a trial of the possibility of transplanting kelp plants and spores to the Atlantic coast and establishing them in suitable localities. If this can be accomplished it will afford a source of potash in close proximity to the large fertilizer markets.

The possibility of recovering potash as a by-product of cement mills and blast furnaces is being called actively to the attention of manufacturers. All the cement mills in the country have been communicated with and arrangements have been made to secure samples from these plants. When analysis of a sample shows a sufficient potash content now volatilized and lost to warrant expenditure for apparatus to recover it, the company will be advised. At the same time figures secured from plants already recovering by-product potash will be furnished. In the same way, a beginning has been made in securing samples from blast furnaces and it is proposed to continue this work actively.

In addition, the question of extracting the potash from wool scourings has received consideration and efforts have been made to get in touch with the companies in the country which are engaged in cleaning raw wool on a large scale. It has been found that several of these companies are either now extracting potash as a by-product or preparing to do so. It is proposed to investigate the methods being used and to urge the extension of the practice in the industry so far as possible.

A number of alunite determinations were made and the fact brought out that the optimum temperatures in calcining alunite for potash recovery fall within comparatively narrow limits, too high a temperature resulting in the formation of insoluble silicates and too low a temperature involving the necessity of using excessive amounts of water in leaching. A bulletin discussing the various methods proposed for treating alunite for potash and giving the results of these experiments was prepared and is in process of publication.

NITROGEN.

The bureau's laboratory at Arlington has been equipped with apparatus for testing the different methods proposed for fixing atmospheric nitrogen, and contracts have been let for much additional equipment to extend this work. This extension of the work has been delayed by the impossibility of securing immediate delivery of machinery.

In connection with the work on phosphates, an electrical furnace has been in operation working on the problem of volatilizing phosphoric acid and fixing nitrogen in one operation. Apparatus has also been installed for experimenting with the Ostwald process of oxidizing ammonia for the production of nitric acid. Both these projects are

attended with technical difficulties and no important results can as yet be announced.

Investigations on city wastes have been continued and an apparatus and processes for rendering garbage and other similar wastes have been devised, which it is believed will prove superior to those now in use for this purpose. A full report on city wastes is now in course of preparation. Some work also has been done in determining the availability of various nitrogenous fertilizer materials when applied to the soil, and this work is being continued.

A study of the subject of ammonia from the by-product coke ovens has been made and published.

PHOSPHATES.

At the Arlington laboratory an electric furnace has been installed and work on the volatilization of phosphoric acid from phosphate rock has been begun. In connection with this work the question arose whether it would not be possible, and, if so, more economical, to collect phosphoric acid by means of the Cottrell precipitator instead of passing the fumes through absorption towers. A precipitator was installed and, while minor adjustments remain to be made, the essential fact that phosphoric acid may be economically collected in this way has been demonstrated. This work involved the installation of electrical equipment for delivering a current of 50,000 volts.

The work on the fertilizer value of raw phosphate rock has been continued, and the final report, giving the results of this investigation, is now nearing completion.

Large supplies of sulphuric acid are used by the fertilizer manufacturers in the preparation of acid phosphate by present methods. A process for producing sulphuric acid has been perfected and patented which gives promise of being much more satisfactory than the process now in use.

GENERAL.

The problem of producing concentrated fertilizers containing all three fertilizer ingredients or any two of them has been attacked from several directions, and methods have been worked out in the laboratory for producing ammonium-potassium-phosphate, potassium-phosphate, and ammonium-phosphate by processes which are new and very promising. Patents on all these processes, for the benefit of the people of the United States, have either been secured or have been applied for.

The scarcity of potash and the high prices asked for phosphates and nitrogenous materials have stimulated the search for sources of potash, nitrates, and phosphates within the country, with the result that a large number of samples have been received with requests for analysis. In many instances these have seemed to offer sufficient hope of disclosing valuable sources of fertilizer ingredients to warrant analysis, and a considerable volume of such routine analytical work has been turned out.

Many requests from private individuals have been received for information on the subjects of fertilizer resources, manufacture, and practice, and wherever possible this information has been furnished. This has involved a large amount of library research in addition to the actual preparation of the replies.

SOIL CHEMISTRY.

Early in the year the soil laboratories were reorganized and the soil chemical investigations were placed in charge of Dr. E. C. Shorey.

This division, while necessarily organized to carry on work of a routine nature for other divisions of the bureau and other bureaus of the department, is carrying on important investigational work along several lines.

The most important of these is the study of the inorganic composition of soils. This includes not only complete analysis of important soil types carried on in close cooperation with the Soil Survey, but also special studies to determine, if possible, the forms in which the various soil constituents are present in soils. To accomplish this, the problem has been attacked along several new lines and along old lines on a scale not heretofore attempted. Equipment has been provided and methods have been studied for the investigation of water extracts of soil made from soil in lots of 1 ton and interesting results already have been obtained.

A phase of this work completed in the past was the determination of the quantities of the rarer elements in soils; as a corollary to this the study of the ash of plants grown on such soils was taken up. This study of ash composition was made with special reference to the presence or absence of the rare elements that had been found in soils. This work has been completed during the year, and the results will be available for publication in a short time.

Another important investigation on which progress has been made during the year is the liming of soils. Greatly increased interest in the use of lime in agriculture has been shown during the year, stimulated, no doubt, by the fertilizer situation, and the investigation has been undertaken with the aim of making the use of lime in agriculture more intelligent. Progress in this work has been made along two lines. The form in which lime is present in a large number of soil types has been determined, and the results are being prepared for publication. This information is necessary to a proper understanding of the results obtained in the second part of the investigation, viz, a study of the chemical reactions that take place when lime is added to a soil. Some interesting results already have been obtained, but this phase of the work is yet in the initial stage.

SOIL PHYSICS.

In the physical laboratory investigations have been continued on excessive soil erosion, the moisture relation of the soil with a special study of the critical moisture content, the pressure exerted by soils under changing moisture conditions, the character and movement of the soil atmosphere with particular attention to the absorbed gases of the soil, and the separation and examination for distinguishing features of the very fine material in heavy clay soils.

In addition to these lines of research, mechanical analyses have been made for the soil survey of the principal soils surveyed during the year and for other bureaus in this and other departments. One man has been continuously occupied in the designing and constructing of special apparatus for use in the laboratories of the bureau. Work has been begun on a detailed study of some of the more important physical properties of the principal soil types.

REPORT OF THE ENTOMOLOGIST.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., August 24, 1916.

SIR: I submit herewith a report of the work of the Bureau of Entomology for the fiscal year ended June 30, 1916.

L. O. HOWARD,
Entomologist and Chief of Bureau.

HON. D. F. HOUSTON,
Secretary of Agriculture.

WORK ON THE GIPSY MOTH AND BROWN-TAIL MOTH.

The work on the gipsy and brown-tail moths was continued as formerly under the direction of Mr. A. F. Burgess. Many improvements in methods have been made as the result of experiments which have been conducted. A large number of parasites have been colonized in areas where they were not known to have occurred previously, and the results of the work on the entire project have been very satisfactory.

STATES RELATIONS AND COOPERATION.—Cooperation with the officials charged with moth work in the various States infested has been maintained throughout the year with good results. This cooperative work has prevented duplication of effort and has enabled each of the States and the bureau to accomplish much more work than would otherwise have been done. Numerous conferences have been held, and more uniform methods have resulted from these meetings.

PROGRESS OF THE GIPSY-MOTH WORK IN NEW ENGLAND.—Scouting work has been carried on in the towns along and just outside the infested border. Two hundred and fourteen towns in all have been carefully examined during the year. Over 12,000 miles of roadways and 24,000 acres of woodland have been examined. The heavy snows of last winter, however, rather seriously hampered work of this kind.

In the woodlands the high elevations have been most carefully searched, as from these places the insect is most likely to be spread. The result of the scouting has been that the gipsy moth has been found in 10 towns in New Hampshire, 2 in Vermont, 2 in Massachusetts, and 1 in Connecticut where it was not known to exist previously. On the other hand, in 2 towns in New Hampshire, 2 in

Vermont, 4 in Massachusetts, and 3 in Connecticut the insect has apparently been exterminated. There is therefore a net increase of only 4 infested towns, which is a much smaller number than has been found in previous years. All of the infestations discovered in these towns have been carefully treated, and a large amount of creosoting, banding, and spraying has been done in towns immediately inside the border. Approximately 35 tons of arsenate of lead were used this year, and spraying was done with 13 high-power sprayers. The purchase during the year of a motor-truck sprayer made it possible to treat a much larger area more economically than heretofore. This machine will do the work of four horse-drawn machines.

There has been a very noticeable decrease in the number of insects in the towns along the border which were treated last year. Considerable work has been done throughout several tiers of towns inside the border in order to prevent continued spread throughout adjoining areas, and here the results have been very satisfactory. The small colonies formerly existing in Great Barrington and Lenox have been thoroughly scouted, but no moths have been found.

PROGRESS OF THE WORK IN OHIO.—The site of the former colony at Bratenahl, a suburb of Cleveland, Ohio, has been thoroughly examined, and as a precautionary measure the trees were sprayed again during the summer by the State nursery inspector. No infestation has been found on this site during the year, and it is believed that the insect has been exterminated.

PROGRESS OF THE WORK IN NEW JERSEY.—The site of the former colony at Rutherford, N. J., has received careful attention, and no indication of the presence of the moth has been found.

PROGRESS OF THE WORK IN NEW YORK.—During the year the entire park system of Rochester has been examined, as it was feared that the moths might have gained a foothold from nursery stock which has been shipped in during the last few years, but no evidence of the insect was found. In the colony which was located at North Castle a large amount of work has been done, but only eight egg clusters have been found, all of these being outside the area which was sprayed last year. Work is being continued at this point in cooperation with the department of agriculture of the State of New York, and the entire area and a surrounding strip have been sprayed this year. Work will be carried on, and it is believed that the insect can be stamped out.

BROWN-TAIL MOTH SITUATION.—The severity of the brown-tail moth infestation has steadily decreased, and the insect is by no means as abundant as it was the previous year. The various light-houses along the coast of Connecticut and Long Island have been examined, but no migrating moths have been found. Fewer moths have been found on trains coming from infested regions during the season when the moths are flying than in any year since this work has been begun. This indicates quite clearly that the moth is not spreading into new territory, and the conditions in the territory known to be infested showed marked improvement and in many of the towns where this insect once caused much damage and annoyance it has done little injury during the year.

QUARANTINE WORK.—The inspection of nursery stock and forest and quarry products has been kept up throughout the year, and in accordance with the new regulations of the Federal Horticultural Board Christmas trees and greens were allowed to be shipped from the infested area after inspection. Shipments of quarantined products numbering 37,444 have been examined and passed, 664 of which were found infested and were required to be treated before shipment was allowed. On these latter shipments 11,159 specimens of the gipsy moth in all stages, except the adult form, and 517 brown-tail moth webs were found and destroyed.

As a result of the effective work which is being carried on along the outside border of the quarantined area, a change has been made in the inspection regulations so that shipments that are being sent into slightly infested territory must be inspected hereafter the same as those that pass outside the quarantined area. This regulation will assist in preventing reinfestation of territory which is being treated and, it is hoped, will hasten the time when the quarantine may be lifted from some of the towns along the outer border.

SILVICULTURAL WORK.—The sample plats under observation to secure data on the best method of thinning infested woodland have been examined from time to time during the year, and much new information has been secured. Final results from these plats can not be expected for several years. Considerable information has been gathered concerning the best methods of utilizing the wood products grown in the infested area, as it would stimulate the elimination of favored food plants of the caterpillar if more profitable markets could be found.

EXPERIMENTAL WORK.—During the year a large number of experiments have been conducted with several kinds of tree-banding material in the effort to reduce the expense of this process. The study of the gipsy moth as a cranberry pest has been continued, special attention having been paid to the dispersion of small caterpillars over the bogs on account of the wind drift. Studies have been made of the increase of the gipsy moth under normal field conditions, the relation of disease and parasites, and the effect of defoliation on different species of trees. An investigation has also been begun to determine the reason why gipsy-moth egg clusters in several localities failed to hatch.

PARASITE AND DISEASE WORK.—The thorough investigation of the so-called wilt disease of the gipsy moth has been continued, and many facts concerning the obscure causative organism of this disease have been secured. Apparently this organism, which is an important factor in reducing the number of gipsy moths, attacks many native caterpillars.

The colonization of parasites imported from Europe and Japan has been continued during the fall of 1915. One hundred and fifty-nine colonies of Japanese egg parasites known as *Schedius kuvanae* were liberated in 28 towns in Massachusetts and 11 in New Hampshire—661,713 individuals in all. During the spring of 1916 another imported parasite of the gipsy-moth eggs, known as *Anastatus bifasciatus*, was colonized in 14 towns in Maine, 31 towns in New Hampshire, and 71 towns in Massachusetts, a total number of 12,286

colonies being liberated, containing 12,286,000 individuals. Recoveries from colonies previously planted in the field have been very satisfactory, indicating that both of these egg parasites are doing good work.

Apanteles lacteicolor, a parasite which attacks small caterpillars of the gipsy and brown-tail moths, has been recovered in greater numbers than during the previous years. *Meteorus versicolor* and another imported *Apanteles*, *A. melanoscelis*, have increased satisfactorily in most of the colonies where they were liberated and have spread over a large area from the original colony site. Specimens have been secured this year so that several new colonies could be liberated.

The imported tachinid fly *Compsilura concinnata* has been recovered in satisfactory numbers this year, and as it attacks many species of native caterpillars it is a very beneficial insect. Another imported tachinid, *Zygobothria nidicola*, has been found more abundantly than before. The *Calosoma* beetle has continued its good work although apparently not so numerous in certain localities as it was last year.

DECIDUOUS-FRUIT INSECT INVESTIGATIONS.

Investigations of insects affecting deciduous fruits have been carried on under the direction of Dr. A. L. Quaintance, as in former years.

APPLE INSECTS.—The studies of the codling moth in progress in Colorado in cooperation with the Colorado Agricultural Experiment Station have yielded much valuable information and are being conducted on a larger scale. Laboratory life-history studies have shown that there are in the Grand Valley two broods of larvæ and a partial third brood each year. An investigation has been carried on as to the distance the moths can fly, day and night records of egg laying have been made, the development of the larvæ on the fruit and shoots of the apple has been studied, and a band trap has been devised for use around the trunk and branches of the apple trees which permits the larvæ to enter to pupate but prevents the exit of moths. This trap has been put to a thorough test and has been found to be of great value in codling-moth control. It will doubtless be adopted by orchardists, since it does away with the need of frequent examination of bands for the destruction of larvæ. Orchard spraying and dusting experiments on a large scale are under way, the plats being so arranged that the results should indicate the most effective times and the minimum number of applications of poison for the control of the codling moth under arid conditions.

The investigation of apple-tree borers has been continued and extended. A detailed account of the roundheaded apple-tree borer is in course of preparation. The period during which this insect, in its larval stage, bores into trees has been found to vary from one to at least four years. It has also been found that the common service tree is very largely responsible for the distribution of this borer in the eastern part of the United States. The proximity of the service trees and a few other trees in the woods to young orchards results in a prompt infestation by this insect. Since the adult females mi-

grate very little, the insects may be reduced greatly by the destruction of their favorite food plant, the service tree. Various paints and washes have been tested, and several of them have been found to be effective against borers.

Evidence has been gained which indicates that what is called "stigmonose injury" to apples is connected with the punctures of the fruit by aphids, particularly the rosy aphid. Spraying experiments in orchards for the control of the rosy aphid resulted in a considerable diminution of the stigmonose injury.

Important biological studies of several species of apple aphids have been carried on. Further experiments in the use of poisonous gases against the woolly apple aphid in orchards have been made. Carbon bisulphid may be applied to the roots by injection or in water poured around the roots. Many tests have been made to determine the dosage which will be effective against the insect and safe to the trees. An essential part of this investigation has been the determination of the effect of soil temperature and soil moisture on the diffusion of the gas, as well as the behavior of the gas in various types of soil, as in clay, shale, or sandy soil.

GRAPE INSECTS.—The biological studies of the grape *Phylloxera* in California have been concluded, and manuscript is in course of preparation for publication. Renovation experiments in vineyards have been continued, and show that by the use of deep plowing, fertilizers, and, when possible, irrigation, much benefit may be derived. In cooperation with the Bureau of Soils, investigation of the relation of *Phylloxera* injury to different types of vineyard soils was continued. This information will be valuable to prospective planters.

Field experiments in the control of the grape-berry moth in the Lake Erie Valley have been continued, and the use of arsenical sprays, hand-picking of the infested fruit, and the covering of the fallen infested foliage in vineyards by fall plowing have been tested. Best results in control were found to follow applications of arsenate of lead at the rate of 3 pounds of the paste to 50 gallons of water, applied immediately after falling of the grape blossoms and about two weeks later. Both of the other methods mentioned, however, are valuable adjuncts to the more effective spraying work. Some work upon this insect was done in cooperation with the Ohio State Agricultural Experiment Station at Sandusky, Venice, Put in Bay, and Kelleys Island.

PEACH INSECT INVESTIGATIONS.—Work on the peach-tree borer has been continued, and special attention has been given to experiments in orchards with the use of various poisonous gases to destroy the insects in their burrows around the base of the trees. It seems that from 95 to 100 per cent of the borers can be killed by the application to the roots of from one-eighth to one-fourth ounce of carbon bisulphid in 1 gallon of water. No injury has been noted from the use of this substance at these strengths, although injury results to trees under certain soil conditions from the use of an ounce or more of carbon bisulphid per tree. The relation of soil moisture and of temperature and physical conditions of the soil to the use of this substance is being thoroughly investigated.

NUT INSECT INVESTIGATIONS.—Investigations of pecan insects, with headquarters at Monticello, Fla., have been continued with success;

much information has been gained about various insect enemies of the pecan; and extensive experiments have been made in orchards on the control of these species.

CRANBERRY INSECTS.—Investigations of cranberry insects in New Jersey have been continued, and material progress made. The field station was changed from Pemberton to Brown Mills, N. J., during the latter part of 1915. The so-called blackhead fireworm was unusually abundant and destructive, but it seems that spraying infested bogs with 40 per cent nicotine sulphate while the insects are in the larval stage is effective. The cranberry rootworm, the cranberry tip-worm, and the bloom worm have also been studied.

ORCHARD INSECTICIDES AND SPRAYING MACHINERY.—This work has been continued and has included the testing of miscellaneous proprietary insecticides and further testing of combinations developed in the bureau. In cooperation with the bureaus of Chemistry and Plant Industry, extensive studies are in progress of the arsenical and other poisonous spray residues present on fruits at harvest time. Chemical examinations are being made of apples, pears, peaches, grapes, and other fruits of known spray history. The general subject of the comparative merits of dust versus liquid sprays in orchards and vineyards has been investigated. In cooperation with the apiculturist of the bureau an investigation has been made of the effect on the honey-bee of spraying apples with arsenicals, during bloom and after falling of most of the petals, according to orchard practice. When the trees are sprayed in full bloom many bees seem to be killed. Spraying at the customary time under normal conditions has no injurious effects on the bees.

Study has been made of the insecticidal constituents of plants, in cooperation with the Bureau of Plant Industry.

NATURAL AGENCIES IN THE CONTROL OF ORCHARD INSECTS.—Special study has been made of the parasites and predaceous insects which assist in controlling orchard pests. In addition, an investigation has been begun of the fungous diseases of insects, an expert being employed for this purpose.

NURSERY INSECT INVESTIGATIONS.—Special attention has been directed to the treatment of the woolly aphis on the roots of nursery apple stock by the use of poisonous gases. The use of carbon bisulphid has been found to be impracticable under nursery conditions. Tests of para-dichlorobenzene in nurseries against this pest show promise. While heavy dosages kill the young trees, applications of the powder at the rate of from 1 to 5 grams per tree appear to be safe and effective in destroying from 95 to 100 per cent of the insects. The odor of para-dichlorobenzene remains in the soil for at least two months and apparently prevents the reinfestation of the roots during that time.

SOUTHERN FIELD-CROP INSECT INVESTIGATIONS.

Investigations of Southern field-crop insects were continued, as in former years, under the direct charge of Dr. W. D. Hunter.

COTTON INSECTS.—The principal pest considered in relation to cotton culture was the boll weevil. During the year investigation

was conducted intensively in the Delta region of the Mississippi Valley, with headquarters at Tallulah, La.

The work of determining the causes of variation in yield of cotton under weevil conditions under apparently similar conditions was continued. Considerable attention was given to the related subject of local variation in weevil injury. This was studied in four Delta counties of Louisiana from the standpoint of weevil emergence, initial infestation, and the varying local conditions of the season. The study of the relation between the spacing of cotton in the row and the date of thinning indicates the best spacing to vary from 18 to 14 inches, according to the nature of the soil, and that the best time for thinning is that usually practiced. The work on direct control consisted principally of plat tests of square picking, weevil picking, and poisoning. It has been found that with an abundance of tenant labor mechanical methods of collecting squares and weevils may give satisfactory results. A new type of poison-dust gun and also a grade of lead arsenate containing a higher percentage of arsenic have been tested, with excellent results in increased production. Life history, hibernation, and parasite studies were continued. Certain chemical products of the cotton plant have been isolated which have proved quite attractive to the weevils. An attempt will be made to utilize these substances.

The annual spread of the boll weevil was determined, as usual, and a map published in the winter showing the progress of the insect, for the use of the State officials concerned in quarantine.

Work on the miscellaneous insects of cotton was conducted throughout the year at Tallulah, La., and Thomasville, Ga. The Batesburg (S. C.) laboratory was discontinued at the end of 1915, and a new laboratory was established at El Centro, Cal. The work on the cotton red spider was concluded and a bulletin prepared for publication. Work was done at Tallulah on the mutilation of cotton seedlings by insects, and at Thomasville important results were obtained in the studies of insects which attack cotton squares and blooms. In cooperation with the Georgia State board of entomology, it was determined that certain species of sucking bugs transmit some of the diseases of cotton. The preliminary work at El Centro has resulted in the determination of the principal causes of insect injury to cotton in the Imperial Valley and will be followed up by studies in control.

TOBACCO INSECTS.—Further improvements have been made in the apparatus for applying arsenate of lead against the hornworms, with the result that a more thorough application may be made at a material reduction in cost. Farm tests were made in cooperation with 280 farmers.

Special studies in control of the cigarette beetle resulted in the determination that storage of manufactured tobacco at low temperatures furnishes an efficient and economical means of preventing loss. Exposure to Roentgen rays under certain conditions is effective in sterilizing the eggs of the beetles. Much of the infestation by this beetle is due to improper methods of hauling and storing the tobacco after it has left the factories.

A new poisoned bait for cutworms, wireworms, and grasshoppers has been tested with increasingly satisfactory results. Valuable data

have been obtained in connection with the efficiency of trap lights for controlling certain tobacco pests, especially the cigarette beetle. In the tobacco budworm work in Florida it has been demonstrated that a special grade of arsenate of lead is far superior to Paris green and results in a saving of at least \$20 per acre.

SUGAR-CANE INSECTS.—Work on sugar-cane insects was continued in cooperation with the sugar experiment station of the State of Louisiana at New Orleans. Practical field tests in the handling of cane trash were continued. A 65-acre poisoning test for the moth borer is now being carried out.

Much experience has been gained in the transportation of parasites of the cane from Cuba, but the results of the importation have not yet been determined.

ARGENTINE ANT.—The control of the Argentine ant in houses, warehouses, factories, and yards has been greatly facilitated by the development of a new poisoned sirup. This has been satisfactorily used at Hattiesburg, Miss., and Augusta, Ga. A bulletin on this phase of the work was prepared.

INVESTIGATIONS OF INSECTS AFFECTING THE HEALTH OF MAN.

The work on insects affecting the health of man dealt with the mosquitoes which transmit malaria, and their control, with the house fly and insects frequenting packing houses, and with the eradication of the Rocky Mountain spotted-fever tick.

MOSQUITOES AND MALARIA.—The work on malaria mosquitoes was continued at Mound, La. This work is directed mainly toward the study of the life histories and habits of the malaria mosquitoes, but considerable attention was directed to the plantation conditions which bring about infection by the disease. The more intelligent classes can obtain practical protection by proper screening and by avoiding foci of infection away from home, but the greatest loss of time occurs in the tenant class. Measures are being evolved to meet plantation conditions in a practical manner. A demonstration of the carrying of malaria by a species of *Anopheles* hitherto considered a noncarrier was made in cooperation with the Tulane school of medicine. This discovery opens up new problems in control. Studies of the biology of the various species of *Anopheles* in relation to the malaria organism are being continued. The cooperative work with the Bureau of Fisheries with regard to mosquito control by top minnows has been continued and extended.

ROCKY MOUNTAIN SPOTTED FEVER.—The control work against the Rocky Mountain spotted-fever tick has been continued in the Bitter Root Valley of Montana during the season of tick activity from March to July, 1916. The general plans of the project have been followed substantially as in the two preceding seasons, with, however, somewhat of a departure in the control program. This consisted in the substitution of a "starvation" plan in one of the control districts for the previously recommended dipping and hand picking of domestic animals in the tick-infested zones, and the success of the substitution has been encouraging. This plan consists

simply of the removal of the domestic hosts of the adult tick from the infested areas, and such a plan appears to be more adaptable to stock-farming conditions and practices in the Bitter Root Valley. A campaign of destruction against the Columbian ground squirrel and other rodent hosts of the immature ticks has been conducted, and as a result of two seasons' efforts it is estimated that the normal squirrel population has been reduced from 60 to 75 per cent.

Owing to the prolonged life cycle and its complications in this species of tick, the effect of the control work is difficult to determine. The examination of 376 ground squirrels during the season gave an average infestation of 0.42 nymph per squirrel as compared to 0.69 per squirrel in 1915, and 4.8 per squirrel under normal conditions as determined in 1910 and 1911—a reduction of 92.3 per cent of the normal and 40 per cent of the 1915 average. The occurrence of human cases of spotted fever during any one season is not a reliable index of the effect of the control work, since there may be a considerable variation under normal conditions and the number of cases is never large. It is of interest, however, to note the development of only one case during the present season in the area in which the operations have been conducted.

THE HOUSE FLY.—The work on the house fly has been continued along the same lines as in previous years. The experiments on the chemical treatment of manure resulted in finding a mixture of calcium cyanamid and acid phosphate which was fairly effective when used in proper amounts. Demonstrational work with maggot traps was continued. An improved type of flytrap was worked out, and numerous baits were tested and compared as to their effectiveness. The most attractive baits were found to be beer, vinegar in sweetened water, banana, and milk. A series of experiments was begun to get exact information as to certain poisoned baits in which such substances as formalin and sodium arsenite were used. A large number of experiments and observations were made on the question of the hibernation of the house fly, with the result that, in the latitude of Dallas, Tex., it was found to pass the winter in the larval and pupal stages. In the latitude of Washington circumstantial evidence indicates that here, also, the immature stages are the overwintering forms, though final direct proof is still lacking.

INSECTS AFFECTING PACKING ESTABLISHMENTS.—Investigations of insects in relation to packing establishments operated under the meat-inspection service of the Bureau of Animal Industry were continued throughout the year in cooperation with that bureau. An agent visited a considerable number of plants in the Western States where the fly problem is of much importance, in some localities continuing throughout the year, owing to the mild winter climate. Suggestions were made to the inspectors in charge which enabled them to take immediate steps toward improving the fly situation in their respective establishments. Studies were made of methods of preventing the breeding of flies under the particular conditions found to prevail in and around packing houses and a considerable number of experiments with methods of destruction of the adult flies were conducted. As a result of tests a very satisfactory trap was developed, as well as improved baits and methods of trap operation, and the information put

into the hands of all establishments operating under Federal inspection. As this information is of very general interest a farmers' bulletin dealing with flytraps and their operation has been published.

AN EMERGENCY MANUAL.—A brief manual of insects injurious to man or likely to carry disease, with remedies for each, was prepared for the Army mobilization, with special regard to health conditions on the Mexican border.

INVESTIGATIONS OF INSECTS AFFECTING THE HEALTH OF ANIMALS.

The investigations of insects which affect the health of animals dealt with flies causing myiasis, with the nose fly, horseflies, horn fly, ox warble, chicken mites and lice, and other species.

THE SCREW-WORM FLY.—The work on the so-called screw-worm and other flies, the maggots of which play such an important part in the live-stock industry in the Southwest, has been continued. Five or six different species of flies have been found to attack living animals. Observations indicate that reasonable control may be expected by proper disposal of carcasses and by altering the plan of breeding and pasturage of sheep and cattle which is now generally in vogue. Experiments show that large numbers of the adults may be destroyed by traps and poisoned baits and also that the method of treating infested wounds may be improved. These lines of work will be continued, and attention will be given to fly-proof pens for calves and wounded animals. Preliminary experiments along this line are encouraging.

HORSEFLIES.—At the request of the Nevada experiment station that the bureau take up the investigation of horseflies in that State, a preliminary survey of the situation in Nevada and California has been made. The horseflies there are of much importance on account of their annoyance to live stock and the quantity of blood they draw in feeding. They also appear to be active agents in the transmission of anthrax from one animal to another in districts where this disease occurs. The problem is being continued in Texas and Nevada.

THE OX WARBLE.—Further inquiry has been made into the distribution and seasonal occurrence of the two species of ox warbles. Not a single case of infestation by the European ox warble has been found in the Southern States, and it is hoped that there is a natural climatic barrier to the spread of the European species into that section of the country. The control of the ox warble on individual farms by systematic extraction of the grubs from the backs of cattle has been continued with satisfactory results.

THE NOSE FLY.—The biology of the newly introduced and rather serious pest of horses known as the nose fly has been rather completely worked out, and a number of the most promising control measures tested in a preliminary way. While a fair degree of protection to work horses from fly attack may be secured by the use of devices to exclude the flies from the noses of the horses, the usual type of nose covering is not applicable to horses in pasture. This necessitates the development of new styles of nose protectors. Substances

for repelling the flies, and others for the destruction of the bots, are being tested. In the course of the work it has been found that a fungous disease appears to destroy a considerable percentage of the bots in nature. This disease is being studied. The relationship between bots and the disease of horses known as infectious anemia is receiving consideration.

POULTRY PESTS.—Extensive investigations of poultry pests, particularly the common red mite and various species of chicken lice, have been carried on with the result that very satisfactory control measures have been developed. It has been determined that sodium fluorid is effective against the lice. A single application of a very small quantity of this material has been found to destroy completely all stages and all species of lice on a fowl. Entire flocks have been cleared up in this manner. These remain free of lice when ordinary precautions are taken against reinfestation by intimate contact with infested fowls. In these investigations the life histories of several economic species of lice have been worked out for the first time. The biology of the chicken mite (*Dermanyssus gallinae*) has been carefully followed for the first time. It has been determined that the mite depends exclusively upon the fowl for its food and will not develop in any stage on filth or excrement. In tests of a large series of insecticides it has been found that a few thorough applications of crude petroleum to the interior of poultry houses will completely destroy the mites. The painting of the roosts and nests with a proprietary compound containing carbolic acid also gave satisfactory results.

CEREAL AND FORAGE INSECT INVESTIGATIONS.

To January last the work on cereal and forage-crop insects was conducted under the direction of Prof. F. M. Webster, who died suddenly in that month; since his death the work has been conducted under the supervision of the chief of the bureau.

ALFALFA WEEVIL.—The alfalfa weevil has spread rapidly during the year, and the territory inhabited by it now extends north to Standrod, Malta, Holbrook, Blackfoot, and Montpelier, Idaho; east to Duchesne, Utah, and south to Richfield, Utah. Valuable information as to the means and extent of its travel, and particularly as to what farm products can be shipped with safety from infested territory, has been collected and given to various quarantine officials, with the result that farm products, except alfalfa hay and commodities which have been packed and handled with alfalfa hay, are now generally admitted to be harmless, and several important markets have been opened to infested districts.

The cost of spraying fields has been reduced from an average of \$1 to 85 cents per acre, and the conditions which insure success have been largely determined. Rotation pasturing has proved a perfect protection against the weevil and a practical method for certain kinds of farms, and it is believed that a study of the farm-management problems of the region inhabited by the weevil will show that most of the farms can profitably use this method. Continuous pasturing of hogs has proved unexpectedly useful in saving the first crop and destroy-

ing the insect so as to permit the growth of a second crop without extra work.

The secondary colonies of European parasites, transplanted from the site of the original importation of 1912, have survived, spread continuously, and have killed as high as 25 per cent of the weevil larvæ present, and all under normal conditions without artificial protection. Much study has been expended upon certain habits of the weevil, which as yet are not perfectly understood.

GRASSHOPPERS.—Extensive investigations looking toward the adaptation to climatic conditions of poisoned baits in grasshopper control were conducted during the year in New England, California, Arizona, New Mexico, and Florida. The summary of the work appears in the Yearbook of the Department of Agriculture, 1915, and indicates complete success. Recent reports from the Connecticut and Merrimac Valleys in New England show that the areas treated for grasshoppers last year are practically free from infestation, whereas untreated areas of the same region are again badly infested. It may now be stated with confidence that the poisoned baits, properly modified in relation to local conditions, afford a safe, cheap, and effective means of controlling these pests throughout the country. The increasing price of most arsenicals has rendered the use of these baits considerably more expensive this summer than before. Considerable difficulty was met during June in the Salt River Valley of Arizona in keeping the bait in condition to be effective.

THE "GREEN BUG."—A severe outbreak of the "green bug" occurred during the year. In the late summer and fall of 1915 the insect multiplied rapidly on volunteer grain, afterwards attacking fall-sown wheat in Texas, Oklahoma, and southern Kansas. As the winter progressed an outbreak of unusual violence was indicated, and warnings to farmers in certain areas were issued through the public press and a circular dealing with the situation was distributed largely throughout the threatened areas. During March and April last the insect increased enormously, chiefly upon oats, and almost totally destroyed this crop in portions of Oklahoma and Kansas. It is estimated that the loss of this crop will total 700,000 acres. Wheat was also damaged to some extent in several States. Investigation showed that the controlling parasites were present, but that they were apparently unable to multiply rapidly enough to be of much help.

THE HESSIAN FLY.—A continuation of the general injury by the Hessian fly reported last year has occurred throughout Missouri, Kansas, Oklahoma, Nebraska, and Indiana. A remarkable phenomenon was the development of a partial third generation in Indiana during the autumn of 1915, which damaged wheat sown at a time which would ordinarily have insured escape from the pest. During the summer of 1915 a circular dealing specifically with the situation was issued and distributed widely throughout the infested region. In spite of the advice given in this circular, wheat was planted largely at such a time that it became heavily infested. This resulted inevitably in very considerable losses to the crop of 1916. Examinations of the stubble indicate a high percentage of infestation at the present time, and unless concerted action of the farmers can

be secured continued and severe injury is likely to result. A special investigation of this insect is in progress.

THE CHINCH BUG.—No severe general outbreak of the chinch bug has developed during the year, although infestations of local importance occurred, especially in Oklahoma and Kansas. It was found that soap solutions were effective in killing the young bugs, but did not control adults. Experiments in control of this pest on St. Augustine grass in Florida indicate the possibility of success with contact insecticides. An effort is being made to improve the ditching and barrier methods of control in the Middle West.

WHITE GRUBS.—As predicted by the bureau, a white-grub outbreak of great severity and magnitude occurred during the year in the States of Iowa, Illinois, Wisconsin, Michigan, Indiana, Ohio, Pennsylvania, New York, New Jersey, and Connecticut. Warnings were issued through the Office of Information of the Department of Agriculture and through the public press. Progress has been made toward the determination of the extent of the various destructive broods of white grubs. Life histories of many species are now known, and the distribution of the species is being accurately determined.

THE FALL ARMY WORM AND THE TRUE ARMY WORM.—During the autumn of 1915 the fall army worm became numerous in the Southwestern States, and was responsible for considerable injury to kafir, late corn, and winter wheat in portions of Oklahoma, Texas, and Nebraska. It appeared also in the Salt River Valley in Arizona, where it assumed the habit of boring into the nearly mature ears of corn in precisely the same manner as the corn-ear worm. This pest has reappeared this season in Oklahoma, and further injury may be done before fall. A new publication dealing with the control of this insect is in the press, and an effort is being made to colonize in Florida, by introduction from New England, a parasitic fly which is an important enemy of the gipsy-moth caterpillars. Two thousand puparia of this fly have been collected in Massachusetts and shipped to Gainesville, Fla., for rearing and liberation in that State so that it can be colonized in numbers, and it is hoped that its work upon the early spring generation of the pest will prevent rapid multiplication and migration.

No important outbreak of the true army worm developed during the year, although the moth was present during the summer of 1916 in the Atlantic States. A new and fully illustrated farmers' bulletin dealing with it has been issued recently.

WIREWORMS.—Studies of the injurious wireworms have been continued. The effect of tile drainage of fields infested by certain species is being investigated, and fumigation of the soil with hydrocyanic-acid gas evolved from sodium cyanid, and with other insecticidal substances, is being tried.

ALFALFA SEED CHALCIS.—An effort has been made to determine the extent of injury by this pest to crops maturing during the different seasons of the year on the Pacific slope. The present loss by this insect to the alfalfa seed crop is estimated at about 30 per cent of all the seed grown in the United States. In the case of some late crops

the loss has reached 80 per cent. The bureau has shown that a great proportion of this loss can be avoided by preventing alfalfa along fence lines and on check ridges, roadsides, and ditch banks from going to seed before the maturing of the regular seed crop. It is shown that the practice of producing late seed crops and pasturing off severely infested fields deserves strong condemnation and should cease.

OTHER INVESTIGATIONS.—Other investigations in this section have been concerned with the range caterpillar in New Mexico, joint-worms, the clover-seed midge, and the clover-root borer in Oregon, and many other species of somewhat less importance.

INVESTIGATIONS OF INSECTS AFFECTING FOREST AND SHADE TREES AND HARDY PLANTS.

Investigations of insects affecting forest growth, forest products, shade trees, and hardy shrubs have been continued, as heretofore, under the direction of the Forest Entomologist of the bureau, Dr. A. D. Hopkins.

THE WESTERN PINE BEETLE.—The most destructive enemy of the yellow pine of the Pacific slope forests is the western pine beetle. An exceptional opportunity has developed during the past two years in the vicinity of the Pacific slope field station at Ashland, Oreg., for an extensive study of this insect. An area of over 2,000 square miles in southern Oregon and northern California is affected. The principal centers of the infestation are on the watersheds of the Klamath, Rogue, and Applegate Rivers. Careful estimates show that over 10,000 trees, representing 8,000,000 board feet, were killed here by this beetle in 1915. Two thousand three hundred of the infested trees have been marked for continuous observations on the development of the broods of the beetles that overwintered in the bark. The area is also divided into units for special cruising experiments and reconnaissance studies and for the purpose of studying the infestation under the varying local conditions. Special cages to include sections of the trunks of large trees, as well as other types of cages and rearing houses, have been devised and constructed to facilitate the attainment of some of the specific objects of the investigations. While it will require several years to complete these studies, the results attained during the year are worthy of note, especially the development of economic methods of conducting reconnoissances and cruises of infested areas and estimating the character and extent of an infestation; in addition, improved methods of procedure in control of the beetle have been worked out.

Demonstration control work on the western pine beetle was carried on under the supervision of a representative of the bureau on privately owned timberlands on the McCloud River of California. This was completed in June, 1915, and has proved a complete success. The project involved 46,470 acres, on which 1,962 infested trees were treated.

INSPECTION OF OLD CONTROL AREAS.—In the fall of 1915 areas in the San Isabel, San Animas, Pike, and White River National Forests and on three extensive private holdings in Colorado where control

work was carried on against the Black Hills beetle from 8 to 10 years ago under the supervision of representatives of the bureau were found to be practically free from infestation by this beetle, which, previous to the control work, had caused the death of a great quantity of the best yellow-pine timber. The inspection showed that there had been a long-continued influence of the control work, not only within the treated areas, but over a wide adjacent and intervening territory.

In November, 1915, an inspection was made of the White Top Purchase Area in Virginia and Tennessee to determine the results of the control work against the southern pine beetle which had been carried on by the Forest Service under the recommendation of the bureau. It was found that the treatment of 1,612 of a total of 2,612 infested trees, or about 61 per cent, served to reduce the infestation on the treated and adjacent areas 96 per cent below the amount of infestation found at the time the control work was started. When it is considered that there had been ample time for the development of at least three generations of the beetle, this is a most convincing demonstration of the economy and efficiency of the methods recommended, and especially of the percentage principle of controlling this most destructive insect enemy of the pine timber of the Southern States.

INSECTS AFFECTING SHADE TREES AND HARDY SHRUBS.—A preliminary survey of Long Island, New York, and of the street and park shade trees of the cities along the coast in Connecticut, Rhode Island, and Massachusetts, was made during the season of 1915 to determine the principal insect depredations on the trees and hardy shrubs and the special needs as to investigations and advice. The results showed that the most important insect problems were represented by the dying hickories and oaks on Long Island. Further investigations revealed the fact that the death of the hickories was due to the hickory barkbeetle and that the death of the oaks was due to defoliation by the cankerworm and forest tent caterpillar and subsequent attack by the two-lined chestnut borer. It was found that tens of thousands of hickories and oaks had been killed by these insects during the past year and that very little had been done to prevent it.

Special attention has been given to determining the distribution of the trouble on Long Island and locating communities in which demonstration control work might be conducted and information and advice given which would enable property owners to save their trees. It was found that the trouble affecting both the hickories and oaks was almost entirely confined to the western end and northern half of the island and principally along the north shore. Demonstration control work was conducted under the supervision of the bureau on Lloyd Neck, where 942 hickories and 911 infested oaks were cut and burned by the property owners, and near Jericho, where 151 hickories and 1,067 oaks were disposed of. In addition, between 8,000 and 10,000 trees have been treated in accordance with the advice given, namely, to locate and mark the trees that die during the summer and fall and cut and utilize them for fuel or other commercial purposes, or pile and burn them during the winter and early spring. An extensive campaign is being carried on this sum-

mer (1916) which, it is believed, will result in enough work being done next winter to control these insects on Long Island and thus set an example for similar work in all of the Northern and New England States.

INSECT DAMAGE TO AUSTRALIAN PINE PLANTATIONS IN FLORIDA.—Complaints received from planters and owners of the so-called Australian pine along the coast of subtropical Florida were investigated in May, 1916. It was found that very extensive damage to the young trees was caused by a flatheaded borer which normally breeds in the red mangrove. Methods of control and prevention were recommended which should bring early relief from the trouble.

DAMAGE TO THE WOODWORK OF BUILDINGS BY WHITE ANTS.—More than the usual number of complaints of damage to the woodwork of buildings by white ants, or termites, have come in during the year from this and other countries. Fifteen cases of more or less serious damage to buildings, including private residences, business houses, a church, a railroad station, and the old building of the United States Bureau of Engraving and Printing, were reported. Many documents in the building last mentioned were damaged or destroyed. Often it has been necessary to advise the reconstruction of foundations and floors to prevent further damage, but in every instance in which the advice of the bureau has been followed no further trouble has been experienced.

EXPERIMENTS WITH INSECTICIDES.—The discovery was made that the addition of sodium arsenate to the ordinary kerosene emulsion at the rate of 1 pound to 2 gallons of water used to dilute 1 gallon of the stock emulsion produced a most effective mixture to kill certain bark and wood boring insects. It has been found by experiments and the subsequent examination of wood-boring larvæ that the poisoned emulsion is much more effective than the pure emulsion and that it is especially adapted for combating certain wood-boring larvæ for which heretofore there has been no practical remedy.

Experiments with various chemical substances to determine their relative effects in preventing attack by wood-boring insects in crude and finished wood products showed that various proportions of creosote plus the kerosene were very effective when thoroughly applied to all parts.

Experiments conducted with poisoned kerosene emulsion and kerosene and creosote, to determine the effect on various wood and bark boring insects which attack living trees and crude wood products, showed that these insecticides were not effective against broods of barkbeetles, but that both the poisoned kerosene and the cresote-kerosene solutions were effective against the hickory and locust borers, the former being relatively the more effective, while in the case of the chestnut-tree borer the poisoned emulsion only was effective.

TWO NEW ACCIDENTALLY INTRODUCED PESTS.—Special attention has been given to a study of two tree pests introduced shortly before the plant quarantine act became operative—the European pine-shoot moth and the European pine sawfly—and caged living trees of various kinds have been utilized in determining many of the obscure

points in the seasonal history and habits, natural enemies, etc., which would contribute to the discovery of successful methods of preventing the establishment and spread of these insects in this country.

INVESTIGATIONS OF INSECTS INJURIOUS TO VEGETABLE AND TRUCK CROPS.

The work of investigating insect enemies of vegetable and truck crops has been in charge, as formerly, of Dr. F. H. Chittenden.

INSECT ENEMIES OF POTATO AND RELATED PLANTS.—An investigation of the potato-tuber moth, begun a few years ago, is practically completed, and a monographic account of this insect from the particular standpoint of its occurrence in California, with methods of control, has been prepared. The natural parasitic enemies of the tuber moth aid materially in holding this serious pest in check. Work on the Colorado potato beetle has been continued, with particular reference to its origin and distribution, and its increasing range westward is being noted. Some additional experiments have been made with control measures. Investigations on the potato flea-beetle, which is a very troublesome pest in some regions, are being continued. Minor insect enemies of potato have been the subject of considerable study, and those of the tomato, eggplant, and other crops related to the potato have been under constant observation. The potato thrips has been studied in southern Texas as injurious to both Irish and sweet potatoes, where it may be the cause of the spreading of potato diseases. Among the most important of these pests are the common stalk-borer, tomato fruit worm, potato stalk weevil, tomato "suck-fly," and other plant bugs, aphids, etc.

SUGAR-BEET INSECTS.—The beet leafhopper has been under continuous observation. It is the cause of the "curly-top" disease of sugar beets, and much has been learned in regard to it during the year. A number of natural enemies, chiefly parasites, have been reared. Particular attention has been given to the relation of wild vegetation, especially weeds such as mallow and chickweed, to sugar-beet infection, and a publication on this topic has been prepared. Work on the sugar-beet wireworms, especially experiments on poison trapping, has been continued. In Colorado continuous study has been given to the sugar-beet webworm, and a report is in preparation. The insect is readily controlled by arsenicals. The western cabbage flea-beetle attracts more attention as an enemy to sugar beets than on its more natural food plants, cabbage and other crucifers, and excellent progress has been made in its study. Arsenate of lead has thus far proved the best means of controlling the pest, acting as a repellent. Where the beetles occur in small areas, dusting with tobacco has given fairly good results. The false chinch bug was the cause of a serious outbreak on sugar beets in Kansas and Colorado. Its abundance has enabled the bureau's agents in those States to experiment with control measures, and the practical results of these experiments are available as Farmers' Bulletin 762. Cutworms in their relation to sugar beets have been studied further, and a publication has been issued on the variegated cutworm. The beet leaf-miner has been studied in New York and California. The sugar-beet

thrips has been investigated, and a bulletin on the same has been prepared.

ONION INSECTS.—An investigation of the onion thrips conducted at various stations, more especially in recent years in Indiana and to a greater extent in southern Texas, as the principal onion-growing regions of this country, is practically completed, and a bulletin dealing with the insect has been prepared. An investigation of the lesser onion thrips has been started in southern Texas. The onion maggot, with other root-maggots, has been studied in Wisconsin. The major portion of this work is devoted to measures of control. The use of tarred-felt pads or disks in Wisconsin continues to be the best remedy, and such growers as have been using them continually since the nineties agree that nothing better could be desired. A great number of other measures have been the subject of experiment against root-maggots, but many of these have proved unsatisfactory.

BEAN AND PEA INSECTS.—The wireworms which are troublesome to sugar beets also affect beans in California, and they have been studied there from the standpoint of bean pests also. The bean ladybird, an important insect enemy of beans in the southwestern region, has received considerable study in southern Colorado. The bean leaf-beetle has also been studied. The pea aphid has not been so destructive as in the past, and, as a consequence, it has not been possible to give it the study which was intended. Nicotine sulphate at the rate of 1 part to 1,800 parts of water combined with soap at the rate of 21 pounds to 50 gallons of water has given very satisfactory results. If growers could be induced to plant in rows instead of sowing broadcast it would be possible to control this pest in the principal pea-growing regions, such as Virginia, Michigan, California, and other States.

INSECTS INJURIOUS TO CRUCIFEROUS CROPS.—The principal insects injurious to cabbage, cauliflower, turnip, and horse radish have been given continued study. A bulletin on the common cabbage worm has been prepared. The cabbage looper and related forms have been kept under observation with a view to complete reports on all of these insects which have somewhat similar life histories and food habits. The cabbage maggot has been studied in connection with the onion maggot, especially in Wisconsin and Michigan. A general article on the horse radish flea-beetle is available. A root aphid which attacks cultivated cruciferous crops in Louisiana has been studied with relation to alternate food plants and methods of control by contact poisons. The diamond-back moth, a well-known enemy of cabbage and turnip, has been studied, especially in Colorado, and the false turnip aphid has been studied in Texas, Louisiana, and Kansas, results proving that it can be readily controlled by spraying with nicotine sulphate in combination with soap under strong pressure. Constant complaints are made in regard to the harlequin cabbage bug, and it is gradually working its way northward. A report covering the general topic with special attention to remedies for combating and controlling this pest is in course of preparation. Such remedies as trap-crop planting and the destruction of the bugs with special burners are among the most successful.

INSECTS AFFECTING CUCURBITS.—The principal enemies of cucumber, melon, squash, and other cucurbits have been studied at various stations. The melon aphid, as formerly, has been the subject of continuous investigation, and the cucumber beetles have been the subject of special work from the standpoint of their action as carriers of the virus of cucurbit diseases, especially of the mosaics, this work being conducted in cooperation with the Bureau of Plant Industry and scientific growers. Special attention has been given to this project in new stations established in Michigan, Wisconsin, and Indiana, the work requiring three experts and three temporary assistants. This work, although preliminary in character, will serve as a foundation for more extensive work during the coming year. The results, while satisfactory in the main, have not entirely reached expectations in the community demonstration work conducted at the field stations mentioned. The lateness of the season and the consequent lateness in the appearance of the beetles and the limited funds for the prosecution of this work at the time when it was necessary to conduct investigations are responsible for this condition. At the Virginia station similar experiments have been conducted on the striped cucumber beetle and the tarnished plant-bug as transmitters of cucumber diseases. A publication on an insect closely related to the common squash bug, which has occurred in injurious numbers in Louisiana, has been prepared. The western and southern cucumber beetles, especially the western striped and the western twelve-spotted and the belted cucumber beetles, have been the subject of considerable study, this work being conducted with a view to more complete publications on these pests.

CONTROL OF THE SPINACH APHIS AND OTHER APHIDS BY LADYBIRDS IN TIDEWATER VIRGINIA.—Research work on the control of the spinach aphid and other aphids by lady-beetles in tidewater Virginia was begun in 1909 and is practically completed. Both the convergent ladybird and the spotted ladybird have proved, under normal conditions, to be almost complete checks on the ravages of these pests, which formerly were a serious menace to the cultivation of spinach, cabbage, and various other truck crops in southeastern Virginia. Prior to the introduction and establishment of these ladybirds it was found impossible to control the spinach aphid because of inability to reach the plants, even with an underspray. This investigation has given the most gratifying results in practically every instance. Conditions in tidewater Virginia are peculiar. The extensive cutting down of trees and removal of underbrush for planting truck crops left no available places for the ladybirds to hibernate, with the result that when work by the Bureau of Entomology was begun it was found that the ladybirds were so scarce as to be absolutely useless as controllers of the aphids. Such conditions have not been reported in any other region, and where the trap-crop method of protection of ladybirds as a means of lessening injury to the main crop has been carried out, it has always met with indifferent results.

In practically all of the stations special attention has been given to the effects of arsenicals and contact poisons, both on the different insect pests and on different plants, and similar attention has been given to the types of sprayers and spraying apparatus most suitable in each case.

INSECTS INJURIOUS TO STORED PRODUCTS.

Investigations having for their especial purpose the control of insects injurious to stored products, especially the grains and mill products, dried meats, fruits, beans and peas, and various seeds and foodstuffs have been continued under the direction of Dr. F. H. Chittenden.

The most injurious insect in this class in the past has been the Mediterranean flour moth. This insect has been studied by the bureau in Texas, Oklahoma, and Kansas, and to a less degree in other States, and by State authorities in the principal milling regions of the Middle West. As a consequence, much has been published on this species, and millers as a general rule are thoroughly familiar with the pest and with the best remedies for its suppression. During the last fiscal year, however, there has been a revival of complaints of its occurrence in flour mills and in commodities other than flour, such as grains, milled and cooked cereals, nuts, and grist products used for feed. Hydrocyanic-acid gas, carbon bisulphid or bisulphid of carbon, and heat have all been employed under different conditions for this and other pests, and various items in regard to methods of control have been added to our store of knowledge on fumigation.

The rice weevil, or corn weevil of the South, continues to cause extensive damage to corn, rice, and other grains in store. Experiments in the destruction of this species have been conducted, especially with heat. The granary weevil and some other insects have attracted attention from their injuries to macaroni preparations and have been investigated.

The methods of wrapping and sealing cartons of cereal products and dried fruits have continued as a project of investigation, the round carton or paper can having been one of the items of study. The belt bean heater designed for the destruction of weevils in beans, especially the broad or Windsor bean, has been the subject of work, and the broad-bean weevil has been under observation. This weevil appears to be on the decrease, owing to the lessened production of its food plant in California. Fumigation against the rust-red flour beetle with hydrocyanic-acid gas was conducted in Virginia with excellent results. Experiments have also been conducted to ascertain the effect of heat on the volatilization of carbon bisulphid with a view to standardizing the dosage required to fumigate under different atmospheric conditions.

The bean, pea, and cowpea weevils continue as a subject of investigation, and much information has been furnished in regard to remedies, for which there is constant demand.

A feature of this work during the year has been the completion of an investigation of the pink corn worm, an insect which infests corn in the field and is destructive to corn and sorghum in the crib. It has been particularly destructive in Mississippi, attracting attention throughout the State. It occurs in neighboring States in the Gulf region, and in Arkansas, Tennessee, South Carolina, and Georgia, and is apt to be troublesome at any time. It can be controlled by fumigation with carbon bisulphid. A comprehensive report on this species has been published as Department Bulletin 363.

A pest which was described in last year's report as new to this country has continued to attract attention from its injuries to cacao

products, such as cocoa and chocolate, and more recently during the past year has been found to be noticeably injurious to rice in store. It also affects dried fruits and other stored products. Special studies of this insect have been made.

The Angoumois grain moth has been studied in relation to its reinfestation of storehouses and cribs from the field. The different species of grain beetles have been under continuous observation, and some new data have been gathered in regard to the life economy of the meal worms. The larder beetle has been studied, and considerable attention has been given to some of the minor insect enemies of stored products which have been introduced into this country recently and are being disseminated by commerce.

The mites which affect flour, dried fruits, and other stored products have been studied with a view to a report on the topic.

Work has been begun with a view to determine whether or not the process of sulphuring to which dried fruits are subjected acts as a more or less permanent protection against insect ravages. Thus far the results have been negative.

New machinery has been installed for determining the effect of heat on insects infesting stored products of all kinds. Preliminary tests have been made.

INSECTS AFFECTING TROPICAL AND SUBTROPICAL FRUITS.

Mr. C. L. Marlatt continued in immediate charge of the bureau's investigations of tropical and subtropical fruit insects.

IMPROVED METHOD OF FUMIGATION.—As indicated in the last annual report, an important advance has been made in fumigation methods. During the year experiments have been conducted with the object of determining the practicability of fumigating dormant and growing plants and various kinds of seeds in a partial vacuum. Definite data have been secured on this method of disinfection, including the effect of the gas on plants and seeds, and the ultimate effect of such treatment on the vitality of the material fumigated.

CITRUS-FRUIT INSECTS IN CALIFORNIA.—The investigation of the citrus mealy bug was continued for the most part along the lines indicated in the last annual report, resulting in the demonstration of successful control. Additional experimental work with hydrocyanic acid gas has been in progress, and a manuscript has been prepared as a concluding report on this method of controlling scale insects on citrus trees. Incidentally other insects affecting tropical and subtropical fruits have been under observation.

CITRUS-FRUIT INSECTS IN FLORIDA.—Investigations have thoroughly demonstrated the practicability of controlling the citrus white fly in Florida at a nominal cost by the proper use of sprays as recommended. It has been demonstrated that the rust mite can be controlled by the use of sulphur at the proper season, thus eliminating the injuries from this pest commonly referred to as "shark skin," "silver scurf," "buck skin," or "russety fruit." Other insects injurious to tropical and subtropical fruits have been under observation.

CITRUS-FRUIT INSECTS IN LOUISIANA.—The investigation of citrus-fruit insects in Louisiana, which has been in progress for something over two years, has been suspended temporarily on account of

the hurricane of the fall of 1915, which so injured the experimental orchards and eliminated the fruit as to make continuation of the work at this time impracticable. In the meantime, the main feature of this work, which relates to the Argentine ant, has been carried on in southern California and is nearing completion. A bulletin giving the results thus far obtained is in course of preparation.

INSECTS AFFECTING TROPICAL AND SUBTROPICAL FRUITS AND PLANTS IN GREENHOUSES.—A very important line of experimental work has been conducted during the year which will eventually result in the standardizing of greenhouse insect control. Greenhouse fumigation with hydrocyanic-acid gas has been standardized, particularly in relation to the dosage which can be used safely for various kinds of plants and the strength of gas necessary for the control of different greenhouse insect pests.

MEDITERRANEAN FRUIT FLY AND MELON FLY.—The control and inspection of fruits shipped from the Hawaiian Islands to the mainland of the United States are conducted in cooperation with the Federal Horticultural Board. During the year the biological studies of the Mediterranean fruit fly and the melon fly and the relation of these pests to bananas and pineapples, the two important export fruits of Hawaii, were completed. The investigation of the usefulness of introduced parasites has been continued and has been enlarged to include thorough biological studies. During the year there have been published the results of experiments on the control of fruit flies by cold-storage temperatures and parasites, and on the status of the banana as a host fruit, and two bulletins have been prepared in which have been summarized the results of the investigational work of the last three years.

BEE-CULTURE INVESTIGATIONS.

The work in bee culture during the year was chiefly a continuation of the lines of investigation previously instituted. As in the preceding year, this work has been conducted at the branch laboratory and apiary at Drummond, Md., a suburb of Washington, under the supervision of Dr. E. F. Phillips.

WINTERING OF BEES.—A continuation of investigations on the wintering of bees has been the principal work of the office during the past year. Because of lack of facilities for extensive experimentation in cellar wintering, the chief emphasis again has been placed on outside wintering. The work on colonies packed in various ways has been continued, but most of the colonies in the experimental apiary were wintered with good results in groups of four, heavily insulated. The various commercial insulated hives used in the United States were tested in the apiary, but were all found to provide insufficient insulation for a climate even as mild as that of Washington. Previous to using these commercial insulated hives for wintering bees they were tested for comparison as to thermal conductivity. It was found that in all of them the part where the most heat is lost is the unprotected hive bottom, and because of this common weakness these hives are practically identical in value as protection for bees. The insulation of the bottoms of these hives was found to increase their

value greatly, and recommendations have accordingly been made to all the manufacturers to build their hives with insulated bottoms in the future. The results of these comparative tests have not been published, but will be included with other data in a general publication on the results of experiments in outside wintering. In connection with the testing of these hives, various insulating materials were tested, and it was found that the choice of an insulating material is of minor importance, since the materials commonly used—shavings, sawdust, leaves, and chaff—do not differ greatly in insulating value.

During the year sufficient progress was made in the work on outside wintering to justify the issuing of a farmers' bulletin (No. 695), giving general directions for wintering in this way. In this bulletin the danger to the colony of excessive heat production is pointed out for the first time, and special emphasis is laid on the necessity of protection from wind.

Beekeepers have repeatedly claimed that excessive insulation is even more detrimental in winter than insufficient insulation, because of the failure of the colony to warm up on bright days. To test this theory, a colony was packed in the fall of 1915 with 16 inches of sawdust on all sides, top and bottom. Temperature records were made at frequent intervals every day throughout the winter and spring. The colony remained in excellent condition in every respect throughout the winter, being little affected by high winds, and after brood rearing began it built up with great rapidity. Then, to continue observations on the effect of insulation on the building up of the colony, the packing was allowed to remain all summer. Except for the impossibility of manipulating the colony, it remained in excellent condition. It seems clear, therefore, that beekeepers need not fear any detrimental results from abundant insulation at any season of the year.

The work of the last four winters has been chiefly on responses to changes in environmental conditions, as shown by the temperature reactions of the colony. To determine the reactions in actual heat production, a preliminary experiment with a colony of bees in a respiration calorimeter was carried out in the fall of 1915, in cooperation with the Office of Home Economics, States Relations Service. Observations were made on the oxygen consumed, the carbon dioxide produced, and the heat generated. Because of the excessive size of the respiration calorimeter used, it was impossible to get results of the desired accuracy as to the amount of heat generated, but valuable results were obtained in the other phases of the investigation which throw much light on the amount of ventilation needed in winter. It is planned to continue this work during the coming autumn with a specially constructed respiration calorimeter.

During the course of the investigation of the wintering of bees about half a million temperature records have been made, together with records of meteorological conditions. These have been charted as rapidly as possible, but it was not practicable to keep up with all the charts. During the winter of 1915-16 the number of colonies under observation was reduced to permit the study of the charts of previous winters. This work is now practically complete, and it is hoped that the results of the various experiments may be prepared for publication in the near future.

THE DEVELOPMENT OF THE BEE.—Studies of the development of the honeybee have been carried on for some time, and a study of the anatomy of the bee larva is now being made. The results of the work on the development in the egg have been published as a private publication. The rate of growth of the larva and the changes occurring day by day are being studied.

DISEASES OF BEES.—Work on the diseases of bees, both in the larval and adult stages, has been continued during the year. A paper giving details of the work on sacbrood was prepared. The examination of samples of suspected brood, sent in by beekeepers from all parts of the United States, has been continued, and this phase of the work is playing a more important part every year in the control of the brood diseases. An unusually large number of samples of diseased adult bees have been received, but in most cases it has not been possible to diagnose such samples, pending the completion of further investigations. The results of the examination of samples of brood have shown several new outbreaks of brood diseases during the year, and of these the State apiary inspectors have been notified at once.

SURVEY OF BEEKEEPING.—On October 1, 1915, a survey of beekeeping conditions in North Carolina was begun, the field work closing at the end of December. The object of this preliminary survey was primarily to learn to what extent demonstration work in beekeeping will be profitable. It was learned that in North Carolina, which is typical of southern conditions, there is much need for extension work in beekeeping and that the beekeepers are eager for information concerning modern beekeeping methods and apparatus. A large number of field demonstrations were conducted, addresses were given in schoolhouses and elsewhere, and many individual beekeepers were visited and advised. In all cases the work was done in close cooperation with the county agricultural agents. The results were so promising, and the interest so keen, that the work will be conducted as an extension project during the present fiscal year, and it is planned to have three field men engaged in the work.

In addition to trying various extension methods as applied to beekeeping instruction, a survey of the beekeeping possibilities of North Carolina was made, and a bulletin prepared. A brief circular of information especially applicable to North Carolina conditions was also prepared, and this is to be issued by the extension division of North Carolina. It is believed that great good will come to the beekeeping industry when the extension work is established, and the bulletins prepared will serve to stimulate interest in the project.

Somewhat allied to the extension work was the holding of a series of 11 meetings of beekeepers' associations in November and December of 1915, attended by the Apiculturist. In December an important conference of teachers, inspectors, and demonstrators in bee-culture was held in Columbus, Ohio, the purpose of which was to discuss the best methods of conducting educational work in beekeeping. Other field meetings of beekeepers have been attended by various members of the office in an effort to make known the results of the investigations of the office.

REPORT OF CHIEF OF BUREAU OF BIOLOGICAL SURVEY.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., August 31, 1916.

SIR: I have the honor to submit herewith a report on the work of the Bureau of Biological Survey for the fiscal year ended June 30, 1916.

Respectfully,

HENRY W. HENSHAW,
Chief, Biological Survey.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

WORK OF THE BUREAU OF BIOLOGICAL SURVEY.

The work of the Bureau of Biological Survey is conducted along five principal lines: (1) Investigations of the food habits of North American birds and mammals in relation to agriculture, in charge of Dr. A. K. Fisher; (2) biological investigations with special reference to the geographic distribution of native animals and plants, in charge of E. W. Nelson; (3) supervision of national bird and mammal reservations, and the preservation of native wild game, in charge of Dr. T. S. Palmer; (4) enforcement of the Lacey Act regulating the importation of birds and interstate shipment of game, in charge of W. F. Bancroft; (5) administration of the Federal migratory-bird law, in charge of George A. Lawyer.

ECONOMIC INVESTIGATIONS.

PREDATORY ANIMAL CONTROL.

On July 1, 1915, an appropriation of \$125,000 became available for use on national forests and the public domain for destroying wolves, coyotes, and other predatory animals. Immediate steps were taken to organize the work on a permanent basis and eight districts were established: (1) Arizona and New Mexico; (2) California and Nevada; (3) Oregon and Washington; (4) Colorado; (5) Idaho; (6) Montana; (7) Utah; and (8) Wyoming. An inspector was placed in charge of each district and an inspector at large has supervision of all field work. Hunters were employed who devote their entire time to the work. They are not permitted to receive bounties from any source, and the skins of all fur-bearing animals taken by them become the property of the Government. A considerable

number of skins secured were retained for museum specimens, the remainder being sold and the proceeds turned into the Treasury.

Three methods of destroying predatory animals have been adopted—shooting, trapping, and poisoning. By the last method the bodies of the animals usually are not recovered, but the results accomplished have been very satisfactory.

During the year 424 wolves, 9 mountain lions, 11,890 coyotes, 1,564 bobcats, and 2,086 miscellaneous wild animals were destroyed. This includes those destroyed under the project for the suppression of rabies among wild animals, an appropriation for which became available March 4, 1916. It does not, however, take into consideration animals poisoned unless the bodies were recovered.

Demonstrations and experiments also were carried on in localities other than on national forests and public lands where predatory animals are causing great losses of live stock. The capture of wild animals in such localities is attended with much difficulty, as they become wary when constantly hunted.

RABIES AMONG WILD ANIMALS.

The project for the suppression of rabies among wild animals, provided for by an emergency appropriation on March 4, 1916, is carried on under the same supervision, organization, and methods that obtain in the predatory-animal control. This work was made necessary by reason of the alarming increase of rabies among wild animals, particularly coyotes, with resulting danger to human beings and loss of live stock. The infested area embraces southeastern Oregon, northeastern California, northern Nevada, and southwestern Idaho. Work was carried on also along the western border of Utah in order to prevent the spread of the disease to that State.

The seriousness of the outbreak will be realized when it is stated that more than 60 persons were treated by State authorities of Nevada during the year on account of exposure to rabies, such persons having been bitten by either wild or domestic animals. The loss of live stock has been very heavy. In a feed lot at Winnemucca a single rabid coyote caused the loss of 27 steers.

It is believed that the vigorous campaign now being carried on will prevent the further spread of the disease, and that within a reasonable time it can be suppressed over the greater part, if not all, of the areas where it now exists.

GROUND SQUIRRELS.

The extermination of ground squirrels from approximately 208,950 acres of Government land was accomplished during the past fiscal year. Of this area about 36,400 acres are on the Fort Totten Indian Reservation of North Dakota, and the remainder on the Modoc, California, and Sequoia National Forests and a few other smaller areas of Government land in California.

The ground squirrel extermination campaign in North Dakota, in cooperation with the State experiment station, is proving very successful, and has involved the use of the enormous quantity of five-eighths of a ton of strychnine in the northern part of the State and the systematic covering with poison of seven counties.

JACK RABBITS.

Demonstrations were held and campaigns organized during the winter to combat jack rabbits in infested farming communities of southern Idaho, central and eastern Oregon, southwestern Utah, northern Nevada, western Texas, and in smaller areas in California. Snowshoe rabbit repression was also undertaken on the Manti National Forest of Utah. Weather conditions were favorable for successful poisoning operations and a great number of these very destructive pests were thus disposed of. Many communities were organized for systematic campaigns for the coming winter.

PRAIRIE-DOGS.

Prairie-dog repression has been carried on with exceptional vigor, and the areas freed of this pest on National Forests and other public domain during the past fiscal year were more than double the total area of previous years. From July 1 to the end of the season 1915, heavily infested Government land had been poisoned to the extent of 886,429 acres, and 164,755 acres previously poisoned had been gone over a second time. From the opening of the poisoning season in April to June 30, approximately 470,000 acres were treated, making a total of 1,356,429 acres of Government land covered during the fiscal year. Of this area 504,393 acres are public lands of eastern Wyoming and southwestern South Dakota, and the remainder is on National Forests in Arizona, New Mexico, Colorado, and Montana, including the Crow Indian Reservation of Montana. The cost of this work varies from 1 to 2 cents an acre in the more lightly infested areas, from 6 to 8 cents an acre where the prairie-dog holes run from 10 to 20 to the acre, or an average of 5 cents an acre. The efficiency of the poison used has averaged from 85 to 90 per cent for one application. Mortality following the use of the poison in the northern States has been much higher, however, being placed at 98 per cent after a careful examination of the areas covered on the Custer National Forest and the Crow Indian Reservation of Montana.

POCKET GOPHERS.

During the fall, 5,390 acres of very heavily infested areas of fine grazing lands were cleared of pocket gophers on the Ochoco National Forest of Oregon, and also 1,280 acres on the Sequoia and 1,100 acres on the Tahoe National Forest of California. Methods of controlling this pest were demonstrated among farming communities in Tulare County, Cal.; in the Rio Grande Valley, Tex.; and in the Mescalero Apache Indian Reservation, N. Mex.

LAND CRABS.

Experiments to determine economic methods of controlling land crabs were conducted in the vicinity of Cocanut Grove, Fla. These pests were estimated to have destroyed 60 per cent of the tomato plants of the locality, as well as quantities of other garden truck. They also damage coconut groves by their numerous burrows. It was found that the crabs could be exterminated by introducing 5

or 6 drops of carbon bisulphide into each burrow by means of a long-nozzled oil can and closing the opening by pressure of the foot.

SEED-EATING RODENTS.

Extermination of rodents which destroy seeds and nursery stock on areas that are being reforested has been completed on the Black Hills National Forest of South Dakota and the Florida National Forest of Florida, and experiments have been conducted on the above planting areas and on the Converse Experiment Station of California. Improved methods for controlling pine mice, wood rats, and other seed-eating rodents have been discovered.

FUR-BEARING ANIMALS.

Investigations of the behavior and requirements of minks and martens in confinement have been continued at Linden, Md., and the National Zoological Park, D. C. Inexpensive types of pens have been devised which are proving very satisfactory. Effects of rations differing in composition and amount have been studied in relation to breeding, fur production, and general health. An understanding of the symptoms and causes of the common ailments of these animals has been gained, and remedial or preventive measures have been adopted. The results attained with these animals and the numerous requests for advice about fur farming have prompted the establishment of an experimental fur farm in northern New York, under conditions favorable to the production of high-grade fur and to the development of practical fur farming. Here experiments may be undertaken on a much larger scale than has hitherto been attempted. It is expected that, ultimately, many kinds of fur animals, foreign as well as native, will be tested as to their adaptability to domestication. One of the most important lines of work to be taken up will be that of developing improved strains by selective breeding. Yards, pens, an ice house, and a storehouse are being erected and soon will be ready for use.

An assistant spent the summer of 1915 in Alaska investigating the present status there of fur farming, and the special needs of those engaged in it. It appears that upward of 100 Alaskans are directly interested in the domestication of fur animals. In 35 localities there are silver-fox yards, and on an equal number of islands blue foxes are farmed. The silver-fox farms are not yet producing fur, but pelts sent to market this season from the older blue-fox farms brought gratifying returns.

During the year two bulletins concerning fur-bearing animals were published, one being a summary of laws in the United States and Canada relating to trapping, protection, propagation, and bounties; and the other a bulletin on silver-fox farming.

FOOD HABITS OF THE THRUSHES.

A report on the thrushes, completed and published during the year, shows that the economic tendencies of these birds are in keeping with their other desirable qualities. The 6 species discussed are found to commit no depredations on crops, but to destroy large numbers of insects, including some that are very injurious.

BIRDS OF PORTO RICO.

During the year a report on the birds of Porto Rico was issued. The work upon which this is based was done at the request of and in cooperation with the Porto Rican Department of Agriculture. The treatise is the most comprehensive on the economic value of birds ever issued for any locality in tropical America, and is one of the most important local bird studies ever made. One hundred and sixty-two species of birds are known to occur in Porto Rico, and the report gives data on the food habits of about 100 of them. In most cases the economic treatment is detailed, and it is shown that a number of the island birds are enemies of the most serious pests of Porto Rican agriculture. Thus 21 species were found to feed upon the changa, or mole cricket, 17 on the cane root-borer, 6 on the stalk-borer, and 6 on the May beetle, all of which are pests of sugar cane.

WILD-DUCK FOODS.

The bureau has published three bulletins dealing with the value and methods of propagation of more than 60 kinds of important wild-duck foods. The information thus furnished has been widely used and is in great demand. A revision of the first two publications on the subject has been prepared, as they are out of print. Much additional information has been included in the revision regarding the plants originally treated, and 40 others are recommended with the view of stimulating dealers to add them to their stocks.

THE INTRODUCED STARLING.

The European starling, long since introduced into the United States, has only recently greatly extended its range. The species is hardy and efficient and well equipped for the struggle for existence. The increase of the bird and its spread into new districts have emphasized the need of an investigation of its economic standing. For some time information has been sought by correspondence and by laboratory examination of stomach contents, and at the present time two assistants are studying the bird's habits in the field. A report on the result of the investigations is planned for the coming fiscal year.

THE CROW.

In an article on "Winter Crow Roosts," published in the Yearbook for 1915, the roosting phase of crow life was fully described and the economic significance of crow roosts discussed. An extensive report on the relation of crows to man was completed. The essential conclusions are that crows are about equally beneficial and injurious, and that they are so wary and sagacious as not to need legal protection. Lack of this, while not endangering the species, will permit farmers to protect their crops or other property whenever necessary.

BIRDS OF THE SOUTHEASTERN STATES.

In response to an urgent need for information on the subject, a Farmers' Bulletin on common birds of southeastern United States has been prepared. It shows that every important insect pest of the South has its bird enemies, large numbers of the corn-leaf beetle, the

green bug, the billbug, the boll worm, the cotton worm, and the cotton-boll weevil being destroyed by hungry birds. No fewer than 66 kinds of birds are now known to eat the boll weevil. On the 100 acres in grain on a single southern farm, birds were found to be destroying approximately a million green bugs daily.

ECONOMIC STATUS OF VARIOUS OTHER BIRDS.

Examination of bird stomachs by groups was completed for two species of crossbills, two of redpolls, the pine grosbeak, the evening grosbeak, three species of godwits, three of curlews, the avocet, the chewink, the scarlet tanager, and the red-eyed vireo. Examinations were brought up to date for the green-winged and blue-winged teals, 7 species of swallows, the wrens, thrashers, and mockers, the creeper, 4 species of nuthatches, 8 species of titmice and chickadees, the wren-tit, starling, fish crow, ravens, and about 13 species of owls.

Swallows as valuable native birds; an index to papers on the food of birds, written by members of the Biological Survey; the food of wild ducks in the sandhill region of Nebraska; methods of attracting birds in northwestern United States; and the care of canaries, are subjects of additional manuscripts, based on this work, which have been prepared for publication.

MORTALITY AMONG WILD DUCKS IN UTAH.

Investigations into the causes of death of large numbers of wild ducks and other waterfowl around Great Salt Lake, Utah, were continued during the field season of 1915. Because of a light fall of snow in the mountain ranges surrounding Salt Lake Valley during the previous winter, water in the streams tributary to Great Salt Lake was very low. In consequence large areas of marsh that in normal years harbor immense numbers of wild ducks were entirely dry and the birds resorted elsewhere. For this reason fewer ducks died during 1915 than in previous years, but still the mortality was enough to be of importance.

In conducting the investigations, an assistant worked in Salt Lake Valley from May until October. Experiments and observations begun last year were carried on mainly in the great marsh areas at the mouth of Bear River. Methods of practical value for the treatment and cure of sick birds by placing them in fresh water were devised that will prove useful in future outbreaks. Though it seems evident that the large number of birds that die suffer from poison apparently due to an alkali absorbed from stagnant water, it was found that many of the affected individuals suffered from lead poisoning as the result of swallowing the lead shot present in large quantities about the shooting stations and blinds. Late in fall, reports were received of many sick ducks at Lake Bowdoin, Mont., and an assistant engaged in the work visited this locality in October in order to study local conditions.

BIOLOGICAL INVESTIGATIONS.

As in previous years, biological investigations have been conducted mainly along lines essential to the effective administration of various other activities of the bureau, including the Federal migratory-bird law; the enforcement of the Lacey Act, regulating importations and

interstate shipments of birds; the maintenance of bird and mammal reservations; and the economic investigations concerning the relations of birds and mammals to agriculture, stock raising, and forestry. The various card indexes containing information in regard to the distribution and habits of the various species of North American birds and mammals, comprising a vast amount of unpublished data gathered by field parties of the bureau as well as information gleaned from published sources, have been very largely increased during the year. These sources of information become increasingly valuable with growth.

DISTRIBUTION AND MIGRATION OF BIRDS.

Reports on the migration of birds were received, as in past years, from more than 300 volunteer observers located in all parts of the United States, in addition to a considerable number from Alaska and Canada. Notable progress was made in mapping the exact distribution of the various species of birds inhabiting North America, and for this work the reports from volunteer observers have been extensively drawn upon. A report on the distribution and migration of gulls was published; a similar report on the terns was prepared, as well as a revised edition of the report on ducks, geese, and swans, in which new information was incorporated; and one on the grebes, loons, and auks was nearly completed.

BIRD ENUMERATIONS.

The results of the second bird count taken in the early summer of 1915 by more than 200 voluntary observers were studied and a report was prepared for publication. The third count taken in the summer of 1916 by about the same number of observers has not yet been critically studied, since the returns are not all in, but as far as can be determined it bears out the conclusions reached from a study of the work of 1915—that where birds are protected there is a marked increase in their numbers, and that intelligent and systematic encouragement, therefore, may be expected to result in a notable increase in the bird population throughout the country, with corresponding benefit to the farmer.

BIOLOGICAL SURVEYS.

Progress was made on the biological surveys of Oregon and Arizona, and work on Montana was begun. A survey of Alabama was nearly completed and a report on the birds of that State prepared for publication. Field work on the survey of North Dakota was finished. A report on the life zones of Wyoming was completed and one on the mammals of that State was well advanced in preparation. Reports on the mammals and birds of New Mexico and on the birds of Texas were practically completed. In the spring of 1916 preliminary studies of the distribution of birds and mammals in parts of Georgia, and North and South Carolina were made.

INVESTIGATIONS RELATING TO MIGRATORY WILD FOWL.

In the summer of 1915 field studies were made on the abundance and distribution of breeding waterfowl in Nebraska, in connection with a special investigation of the food plants of these birds.

Reports embodying the results of these investigations are nearly ready for publication. An investigation of the breeding and distribution of waterfowl in North and South Carolina and Georgia was made in the summer of 1915. Field investigations on the abundance and distribution of waterfowl in their winter homes were carried on in Alabama in the autumn of 1915 and an investigation of the distribution of breeding waterfowl of North Dakota was begun early in the summer of 1916.

STUDIES OF ELK IN YELLOWSTONE NATIONAL PARK.

In cooperation with the Forest Service, an investigation of the condition of the elk herds in the region of Yellowstone National Park was instituted for the purpose of providing for their future welfare. The summer and winter ranges in that region were examined in order to ascertain the areas necessary to be reserved for the use of the animals. Early in the spring of 1916 a cooperative count of the elk of that region was made, which showed that the southern herd contained about the same number as had been previously reported (approximately 18,000). The northern herd is shown to contain only about a third of the number it was supposed to hold. This investigation is important, since the increased occupation of the western ranges by cattle and sheep renders it imperative that if the game herds are to be preserved provision for their protection be made in advance. The majority of all the elk left in the United States are concentrated in and about Yellowstone National Park and this reservoir for restocking other areas is too important to be neglected.

TECHNICAL INVESTIGATIONS.

A large number of specimens of birds and mammals were identified at the request of State and other institutions and of individuals. Technical revisions of the American moles, the pocket gophers, and the prairie-dogs were published as North American Faunas, and revisions of the flying squirrels, rice rats, and grizzly and big brown bears were prepared for publication. These studies involved the examination and identification of large numbers of specimens, including, in addition to the collections of the Biological Survey and the United States National Museum, much additional material borrowed from other museums.

Besides the technical studies of mammals prepared for publication, many data of this character are embodied in manuscript maps illustrating the distribution of mammals. These show in graphic form the area inhabited by practically every species of North American mammal. Much work in correcting and amplifying these maps has been accomplished during the year.

GAME PRESERVATION.

RESERVATIONS.

The Biological Survey is charged with the maintenance of 72 reservations, 5 of which are big-game preserves and 67 bird reservations. The mammal reservations include the Montana Bison Range, the Wind Cave Game Preserve in South Dakota, the Niobrara Reser-

vation in Nebraska, the Elk Refuge in Wyoming, and the Sullys Hill Game Preserve in North Dakota. The Niobrara Reservation was intended as a bird reserve, but has been stocked with big game and is at present maintained chiefly for buffalo and elk. In the first three reservations above mentioned the herds of buffalo have shown a notable increase since their establishment a few years ago, and now include 207 head, or more than a third of all the buffalo which now belong to the Government. The elk number about 159 and the antelope 40, making a total of about 400 head of big game.

GAME PRESERVES.

MONTANA BISON RANGE, MONT.—The herd of buffalo is in very satisfactory condition. With the addition of 24 calves (14 males and 10 females), born this year, and the loss of 1 bull, the total number is now 165, of which 79 are bulls and 86 cows, an increase of more than 400 per cent since the herd was placed on the range in 1909. The herd of elk has been increased by the addition of 26 transferred from Yellowstone National Park in February, and now numbers about 65. The number of antelope was increased by a donation of 3 animals by a citizen of Deer Lodge, Mont., and 1 female by the Oregon Fish and Game Commission, and numbered 26, including the fawns of this spring.

WIND CAVE NATIONAL GAME PRESERVE, S. DAK.—At the beginning of the year there were 40 head of big game in the preserve, including 16 buffalo (6 bulls and 10 cows), 9 antelope, 14 elk, and 1 deer. Since that date the number has nearly doubled by births, and other additions to the herd. The births include 6 buffalo calves, 23 elk, and 9 antelope. Twenty-five elk were transferred from Yellowstone Park in February and 6 buffalo in June. The losses during the year included 4 antelope—2 adults and 2 fawns. The number of animals now on the reservation includes 28 buffalo, 62 elk, and 14 antelope, making a total of 104.

An important improvement has been made in clearing a fireguard 2 rods wide along the fence on the west side of the reservation, and efforts have been made to render the inclosure coyote proof by filling in with rock all the low places under the fence. The buildings and fences are in good condition and except for the losses in the band of antelope the outlook for the preserve is very encouraging.

WYOMING ELK REFUGE.—Purchase of a 520-acre tract mentioned in the last annual report has been completed, and application made to the Department of the Interior for the addition of 160 acres of public land under the terms of the act of March 4, 1913. This addition will make the total area of the elk refuge 2,760 acres. Improvements made during the year include the construction of about 2 miles of fencing. Hay harvested in the autumn of 1915 amounted to nearly 500 tons and most of it was used in feeding the elk. The winter was rather severe and feeding began on January 12 and continued until March 27. At one time in January there were about 3,000 head of elk on the reserve. A number of deaths, chiefly confined to calves, occurred among the elk both on the reservation and other points in Jackson Hole. The number of calves which died on the refuge was 208, or less than 1 per cent of the total fed. Many elk seemed to suffer from some obscure digestive trouble of which no satisfactory diagnosis was made. Some reports attributed the cause of death to feed-

ing musty hay, either old hay, or hay which had been put up during wet weather, but observations on the refuge did not support this theory and the real cause remains uncertain.

NIORRARA RESERVATION, NEBR.—At the beginning of the year the herd included 11 buffalo, 28 elk, and 2 deer. During the winter 4 of the elk died. With the addition of 3 buffalo and 8 elk calves, the herd now numbers 14 buffalo, 32 elk, and 2 deer, or a total of 48 head.

The herd has practically reached the limit of the present inclosure, and, beginning December 15, feeding became necessary in severe weather, as the grass had been eaten off during the summer. The hay is cut on the reservation by the warden, and the expense of feeding is thus practically nominal.

SULLYS HILL GAME PRESERVE, N. DAK.—Under the additional appropriation of \$5,000 for the improvement of the game preserve in Sullys Hill National Park, N. Dak., a new contract was let for the construction of an 88-inch woven-wire fence some 6 miles in length for the inclosure in the park, the contractors having found it impossible to proceed under the first contract. New bids were called for and a contract let for the construction of the fence at a price somewhat less than the appropriation now available. Under this contract the ground was cleared along the line of the fence during the winter and the work of construction taken up as soon as conditions in spring permitted. Plans for next year will include building the necessary headquarters, barns, and buildings, and stocking the reservation with a herd of elk and other big game.

TRANSFER OF GAME.

Owing to severe weather and the necessity of concentrating attention on the feeding of elk, no effort was made to transport any animals from Jackson Hole this season. Through cooperation of the Department of the Interior and the Forest Service 100 head of elk were transferred from Yellowstone National Park. Fifty of these were placed on national forests in Colorado; 25 on the Wind Cave National Park, S. Dak.; and 25 were shipped to the Montana Bison Range. Six buffalo also were transferred from Yellowstone Park to Wind Cave Park in June.

NATIONAL BIRD RESERVATIONS.

The number of bird reservations was increased during the year by the addition of the Big Lake Reservation in Arkansas, established under Executive order of August 2, 1915. This makes 70 reservations established to date. Of these the Pribilof Reservation, Alaska, has been transferred by act of Congress to the Bureau of Fisheries, in the Department of Commerce; the Blackbeard Island Reservation has been abandoned as a national reservation and leased to the State of Georgia, and the Niobrara Reservation thus far utilized chiefly for big game, leaving 67 reservations maintained primarily for birds.

Under the limited appropriation available for maintenance of reservations, warden service for longer or shorter periods of time has been provided by the Bureau of Biological Survey for about a third of the reservations. Through cooperation of the Reclamation and Forest Services, protection has been afforded birds on about as

many more of the reservations which are located on reclamation projects or in national forests. The Lighthouse Service has cooperated in protecting the Siskiwit and Huron Islands Reservations in Michigan, and the Smith Island Reservation in Washington; and the Coast Guard Service, of the Treasury Department, and the Navy Department have cooperated in guarding the Hawaiian Islands Reservation. About 20 reservations are at present without warden service of any kind, but half of these are so remote or difficult of access that there is comparatively little danger of the birds being molested. Of the others, warden service is urgently needed on Big Lake, Ark.; Aleutian Islands, Alaska; East Timbalier, La.; and on the Hawaiian Islands.

Several projects for draining lands in the vicinity of the Klamath and Malheur Reservations in Oregon and the Big Lake Reservation in Arkansas, as well as projects of similar kind for draining private lands in various parts of the country, emphasize the importance and necessity of retaining as breeding grounds for waterfowl and other birds tracts of land which are not especially valuable for agricultural purposes. Only in this way can proper provision be made for the maintenance and increase of an adequate supply of waterfowl. The area of marsh land necessary for breeding grounds is insignificant in comparison with the area over which the birds will spread during their migration and the benefits which will accrue to States and the general public through the increase of this important element in our supply of game birds.

KLAMATH LAKE, OREG.—Conditions on the reservation are somewhat unsatisfactory, owing to the uncertainty as to various plans for draining the lands on the Klamath Reclamation Project. Construction of a railroad embankment several years ago has increased the difficulty of patrolling the reservation, but has also made it difficult for boats to reach the lower part of the lake, and consequently the birds are less disturbed during the breeding season. In October a tule fire burned over a large area in the southwestern part of the reservation, destroying many minks and driving out the birds. This fire also burned fences and damaged pasture lands on several neighboring private holdings. Since the elimination of lands in 1915, a number of applications have been made for permits to file homestead entries within the reservation, but all have been rejected, both by the local office and, on appeal, by the General Land Office.

LAKE MALHEUR, OREG.—The usual large number of waterfowl and shorebirds bred on the reservation during the past season and 4,635 muskrats and 17 minks were trapped during the open season in fall and early winter. A recent report indicates that many muskrats were frozen to death during severe weather late in the winter. Several well-defined movements have been set on foot at various times to drain Malheur Lake and throw the land thus reclaimed open to settlement. One of the latest plans is to shut off the water now flowing into the lake through Blitzen and Silvie Rivers and deepen the outlet to Harney Lake. Malheur Lake is very shallow and 12 feet higher than Harney, and by deepening the channel its waters would drain into Harney Lake and much of the surrounding marsh and tule land be reclaimed. No actual work on this project has yet been undertaken.

SMITH ISLAND, WASH.—The value of this reservation as a refuge for waterfowl has been clearly demonstrated during the past winter. Several species of ducks, notably widgeons, occurred about the reservation in such numbers as to cause complaints of damage to clover fields in the vicinity. An inspector sent to investigate the matter ascertained after careful examination that the damage was local and by no means serious. Application was made to the Department of Commerce for permission to use the lighthouse reservation as a basis for operations for gathering kelp in the vicinity of the island. These operations will be confined to three months during the summer, and in the permit which has been issued provision has been made for protection of the birds.

FORRESTER ISLAND, ALASKA.—The number of birds on this reservation was about the same as in 1914, except that an additional colony of Cassin auklets was found which was not noted last season, and forked-tailed petrels were apparently less plentiful. The warden reported that fishing during the season of 1915 showed a decided improvement over that of the previous year, although the number of fishermen on the reservation was much smaller, only about 180 permits being issued as against more than 500 during 1914. Several hard wind storms visited the island, one particularly severe, on July 5-6, doing considerable damage to the boats.

HAWAIIAN ISLANDS.—On September 25, 1915, the American schooner *O. M. Kellogg*, bound for San Francisco from a point in the South Pacific went ashore on Maro Reef, not far distant from Laysan Island, and the captain and his crew made their way safely to that island, where by chance they found Capt. Max Schlemmer with two companions, who had landed a short time before. With the aid of Capt. Schlemmer's yacht *Helene* the crew of the *O. M. Kellogg* reached Midway Island, and were safely transferred to Honolulu by a naval tug. Subsequently, the U. S. S. *Nereus* returning from Japan stopped at Laysan and brought back Capt. Schlemmer and his two companions.

During the last cruise of inspection of the Coast Guard cutter *Thetis* in March and April, 1915, a landing was made on Nihoa, or Bird Island. This precipitous rock rises to a height of some 500 feet above the sea and has remained one of the most inaccessible islands in the reservation. Among the interesting birds found was a finch supposed to be related to the species which occurs on Laysan. On Laysan Island no vegetation was left and all the rabbits which had been introduced some years ago had disappeared, evidently showing that the rabbits had eaten all the vegetation and had then perished through lack of food. There was no evidence that the birds had been disturbed by poachers. On Laysan Island there was a marked improvement in the condition of the birds over that of the previous year. Many more albatrosses were found breeding, thousands of the Hawaiian terns were nesting, and 35 of the rare Hawaiian teal were seen, more than twice as many as were previously reported.

IMPORTATION OF BIRDS AND MAMMALS.

Continuance of the war in Europe has had an even more noticeable effect on the importation of birds and mammals than during

the previous year. Only 411 permits were issued as compared with 454 in 1915. Inspections during the year numbered 163, as compared with 150 in 1915, and 188,117 birds and 3,149 mammals were imported under permit. Among these were 127,706 canaries, 11,547 miscellaneous game birds, and 41,626 nongame birds. Besides these, 44,827 birds and 312 mammals requiring no permits were admitted to entry. No cases of entry of prohibited species were discovered during the year.

War conditions are responsible for the almost total absence of European partridges and for the small number of pheasants in the shipments this year, and even the importation of the latter birds from Canada shows a noticeable falling off. On the other hand, there has been a remarkable increase in the number of permits for the entry of foxes from the Maritime Provinces of Canada, due to the unusual interest in fox farming in the United States. There has also been a falling off in the importation of parrots from Mexico.

Notwithstanding the difficulty of obtaining stock through the usual channels, the principal zoological gardens have secured a number of rare and interesting species, some of which have been placed on exhibition in the United States during the past year for the first time. Among these may be mentioned the red bird of paradise and the tiny Wilson bird of paradise, natives of the Island of Waigiu, near New Guinea. A pair of each of these rare birds, the first ever brought alive to the United States, reached New York, December 27, 1915, for the New York Zoological Park. That park also received a pair of the rare greater bird of paradise (*Paradisea apoda*), two young giant herons (*Ardea goliath*) from Africa, and a cock of the rock (*Rupicola rupicola*) from Guiana.

IMPORTATION OF QUAIL FROM MEXICO.—The issue of permits for the importation of quail from Mexico was resumed in the autumn under formal regulations for the entry of the birds, promulgated November 1, 1915. The port of entry on the Rio Grande was changed from Brownsville to Eagle Pass, Tex., and, as heretofore, birds imported by steamer were entered at New York. Through cooperation with the Bureau of Animal Industry, actual inspection and quarantine were carried out under the supervision of the inspectors of that bureau at the ports of Eagle Pass and New York. Practically every shipment which arrived at New York was infected with quail disease. Many birds died en route or shortly after arrival and very few survived the period of quarantine. Quail disease was also detected in a shipment at Eagle Pass, and on January 22, 1916, further importations were suspended. As a result the total number of birds for which permits were issued was 12,989; of these only about 8,000 were actually imported.

Reports of the death of some of the birds which survived quarantine led to investigation of the cause of such loss, and examination of specimens sent to the department showed the presence of bird pox (*Epithelioma contagiosum*), a disease common in poultry, but one which seems this year to have caused serious loss among imported quail for the first time. Many of the birds affected seemed to have been injured in transit and it is possible that the prevalence of the malady this year was due to the type of crates used by shippers.

Before next season a public hearing will be held at which shippers and others interested in the importation of quail will exchange views and aid the department in formulating revised regulations to prevent the introduction of birds affected either with quail disease or bird pox.

INFORMATION CONCERNING GAME LAWS.

The game laws of the various States for the year have been carded, thus keeping up to date the index of game legislation. Owing to the demand for information on certain topics of game legislation, work on a subject index has been actively prosecuted and memoranda on some of the more important phases prepared. This index will be compiled as rapidly as time permits. The regular annual publications, including a directory of game officials, the sixteenth annual summary of game laws, a general poster showing open seasons for game, and a local poster showing open seasons for North Carolina, where there are many laws applying to particular counties, were issued and widely distributed. Sets of ready-reference card maps illustrating in condensed form five topics of game legislation of special interest to various State game officials also were published.

INTERSTATE COMMERCE IN GAME.

Illegal exportations of game from various States, involving violations of sections 242, 243, and 244 of the Criminal Code of the United States, known as the Lacey Act, are becoming fewer with a more rigid enforcement of the Federal law under a reorganization of the force which went into effect March 1, 1916. Three inspectors are now employed, having their headquarters accessible to points where illegal shipments have been most frequent. Forty-five cases have been reported to the solicitor's office during the year, 18 of these since March 1. The cases involved violations in 19 States. Game illegally shipped consisted of partridges (ruffed grouse), wild ducks, reed birds, Carolina rails or soras, quail, squirrels, and deer. One shipment, comprising 1,162 pounds of venison, was made from Michigan, for which a fine of \$200 was imposed. Only 15 cases of violations remain on file for investigation, but this number does not include cases in hands of inspectors but not yet reported.

Fifty-five cases, including some reported in the previous fiscal year, were disposed of by the Department of Justice, as follows: Thirty-four by conviction and the imposition of fines aggregating \$906 and jail sentences aggregating 103 days; 1 by directed verdict of not guilty; and 20 by dismissal for want of sufficient evidence, inability to identify defendant, or removal of defendant from the district.

With the practical termination of illegal shipping of wild waterfowl from the sunken-lands district in northeastern Arkansas, and with the special attention now being given the matter in the larger cities in the North, progress has been made in the conservation of wild game birds so far as illegal sale and shipment to market is concerned. Special attention will be directed to a few prominent cities in the South, where reports indicate that wild waterfowl are being illegally shipped during certain periods of the year.

FEDERAL MIGRATORY-BIRD LAW.

Pursuant to the provisions of the act of March 4, 1913, authorizing and directing the department to adopt suitable regulations prescribing and fixing closed seasons for migratory birds (37 Stat., 828, 847), regulations were prepared and promulgated October 1, 1913, and amended October 1, 1914. During the year the bureau has received a large number of petitions, requests, suggestions, and protests touching various regulations, chiefly urging longer open seasons and spring shooting. All have been given careful consideration, and many were embodied in proposed new regulations made public May 20, 1916. The law provides that a period of three months from that date shall be allowed in which these regulations may be examined and considered before new regulations may be finally adopted and submitted to the President for approval.

For administrative purposes the United States is divided into 13 districts now under the supervision of 16 inspectors. During the year the number of inspectors was reduced from 17 to 16, the commissions of 42 Federal wardens were terminated, and 43 new wardens were appointed, the present warden force numbering 195.

During the first year the regulations were in operation 17, and during the second year 12, cases were tried in district courts of Oregon, California, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Michigan, Arkansas, and Louisiana, and all but 5 resulted in convictions and impositions of penalties. Fines were paid in 18 and suspended in 6 cases. In 4 cases demurrers and in 1 case motion in arrest of judgment were sustained. Twenty-five cases are now pending in district courts in various parts of the country, and 33 additional cases are ready to be submitted to the Department of Justice. In addition, 564 reports of violations have been forwarded to the bureau, but transmission of these to the Department of Justice is withheld pending decision of the United States Supreme Court in the case of United States against Harvey C. Shauver, involving the constitutionality of the law.

That the violations reported by no means approximate the number that have occurred is to be expected and is due to the impossibility in many cases under the law of securing evidence sufficient to convict. It is obvious that to patrol the shooting sections of the United States properly with 16 district inspectors is an impossibility, and the nominal salary paid Federal wardens justifies them in spending only a small portion of their time in the enforcement of the law. Possession of wild fowl during the closed season is not a violation under the Federal act, and there must be evidence of actual shooting or capture on which to base a prosecution. Furthermore, inspectors and wardens appointed under authority of the law have no power of arrest, and hence many violators escape.

As the activities of the inspectors have been confined mainly to "trouble zones," large sections have necessarily been left without supervision, but in such instances State authorities, cooperating with Federal wardens, have rendered efficient assistance. With a few notable exceptions, State legislatures have made progress in line with the Federal law and regulations.

Notwithstanding the difficulties attending enforcement, the law is very generally observed, and communications received from game

and fish commissioners and other persons contain incontrovertible evidence that since the law became effective there has been in most of the States a very marked increase in the number of wild fowl and shorebirds; that wild fowl have become unusually tame in spring; and that many thousands of waterfowl are breeding in certain localities where they had not nested for many years. The consensus of opinion attributes these greatly improved conditions to the abolition of spring shooting and the general observance of the regulations. These results following so soon after its enactment have proved the efficacy of the law and are an earnest of the results to come.

REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF ACCOUNTS AND DISBURSEMENTS,
Washington, D. C., September 14, 1916.

SIR: I have the honor to submit herewith a report of the work of the Division of Accounts and Disbursements for the fiscal year ended June 30, 1916.

Respectfully,

A. ZAPPONE,
Chief of Division.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

CHARACTER OF WORK.

The chief of the division and disbursing clerk is charged by the Secretary of Agriculture with the duty of preparing all requisitions for the advance of public funds from the appropriations for the Department of Agriculture to the disbursing clerk and to special disbursing agents charged with the disbursement of public funds; the keeping of accounts and appropriations ledgers relating to the advance and disbursement of all items of appropriations; and the examination and payment of all vouchers and pay rolls submitted from the various offices, bureaus, and services of the department. He performs such other duties as may be prescribed by the Secretary.

WORK OF THE YEAR.

APPROPRIATIONS, EXPENDITURES, ETC.

To carry on the work of the Department of Agriculture during the fiscal year ended June 30, 1916, Congress appropriated \$22,971,782 in the agricultural act for that fiscal year, in addition to which permanent annual appropriations, special appropriations, deficiency appropriations, and the appropriation for printing and binding were available, amounting to \$6,047,921.98, making a total of \$29,019,703.98, of which sum \$22,320,158.85, was disbursed prior to the close of the year, leaving a balance at the end thereof of \$6,699,545.13, which is nearly all covered by outstanding liabilities.

Supplemental accounts for the year 1915 were also paid, amounting to \$1,544,421.34.

On June 30, 1916, the unexpended balances for the year 1914, amounting to \$763,121.30, were finally covered into the Treasury to the "Surplus fund."

There were received, examined, and paid by this office 127,782 vouchers and pay rolls, which required the issuance of 220,110 checks on the Treasurer of the United States.

There were also sent to the Treasury Department for payment 6,285 accounts.

LOST CHECKS.

During the year 140 checks were lost in transit through the mails or by the payees, and were duplicated by this office.

PUBLIC MONEYS RECEIVED FROM VARIOUS SOURCES.

There were received from various sources and deposited in the Treasury to the credit of the proper funds the following sums:

Sale of cotton standards.....	\$5, 636. 70
Cost of cotton-futures disputes.....	9, 960. 90
Sale of loose cotton.....	22, 972. 19
Sale of photo prints.....	446. 62
Telegrams over Government lines.....	5, 655. 00
Sale of hearings.....	242. 65
Sale of card indexes.....	318. 84
Sale of other miscellaneous Government property, refunds on mileage books, etc.....	42, 599. 39
Sales of products, agricultural station, Hawaii.....	339. 95
Sales of products, agricultural station, Porto Rico.....	828. 55
Sales of products, agricultural station, Alaska.....	933. 38
Sales of products, agricultural station, Guam.....	193. 02
Total.....	90, 127. 19

STATEMENT OF APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE.

[Fiscal years 1839 to 1904, inclusive.]

Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.	Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.
1839..	\$1, 000. 00	\$1, 000. 00		1872..	\$197, 070. 00	\$195, 977. 25	\$1, 092. 75
1840..				1873..	202, 440. 00	201, 321. 22	1, 118. 78
1841..				1874..	257, 690. 00	233, 765. 78	23, 924. 22
1842..	1, 000. 00	1, 000. 00		1875..	337, 380. 00	321, 079. 83	16, 300. 17
1843..				1876..	249, 120. 00	198, 843. 64	50, 276. 36
1844..	2, 000. 00	2, 000. 00		1877..	194, 686. 96	188, 206. 19	6, 480. 77
1845..	2, 000. 00	2, 000. 00		1878..	198, 640. 00	197, 634. 94	1, 005. 06
1846..	3, 000. 00	3, 000. 00		1879..	206, 400. 00	206, 360. 00	40. 00
1847..	3, 000. 00	3, 000. 00		1880..	199, 500. 00	198, 361. 72	1, 138. 28
1848..	4, 500. 00	4, 500. 00		1881..	275, 460. 81	267, 608. 84	7, 851. 47
1849..	3, 500. 00	3, 500. 00		1882..	363, 011. 05	354, 482. 39	8, 528. 66
1850..	5, 500. 00	5, 500. 00		1883..	456, 396. 11	438, 941. 72	17, 454. 39
1851..	5, 500. 00	5, 500. 00		1884..	416, 641. 10	413, 618. 00	3, 023. 04
1852..	5, 000. 00	5, 000. 00		1885..	655, 930. 25	558, 934. 89	96, 995. 36
1853..	5, 000. 00	5, 000. 00		1886..	677, 973. 22	519, 196. 11	158, 777. 11
1854..	10, 000. 00	10, 000. 00		1887..	657, 641. 81	628, 287. 14	29, 354. 67
1855..	50, 000. 00	50, 000. 00		1888..	1, 027, 219. 06	1, 011, 282. 62	15, 936. 44
1856..	30, 000. 00	30, 000. 00		1889..	1, 134, 480. 60	1, 033, 590. 22	100, 890. 38
1857..	75, 000. 00	75, 000. 00		1890..	1, 170, 139. 11	971, 823. 62	198, 315. 49
1858..	63, 500. 00	63, 157. 25	\$342. 75	1891..	1, 372, 049. 21	1, 266, 277. 36	105, 771. 85
1859..	60, 000. 00	60, 000. 00		1892..	2, 303, 655. 75	2, 253, 262. 29	50, 393. 46
1860..	40, 000. 00	40, 000. 00		1893..	2, 540, 060. 72	2, 355, 430. 25	184, 630. 47
1861..	60, 000. 00	60, 000. 00		1894..	2, 603, 855. 58	1, 977, 469. 28	626, 386. 30
1862..	64, 000. 00	63, 704. 21	295. 79	1895..	2, 506, 915. 00	2, 021, 030. 38	485, 884. 62
1863..	80, 000. 00	80, 000. 00		1896..	2, 584, 013. 22	2, 094, 916. 42	489, 096. 80
1864..	199, 770. 00	189, 270. 00	10, 500. 00	1897..	2, 448, 763. 53	2, 348, 612. 98	100, 250. 55
1865..	112, 304. 05	112, 196. 55	107. 50	1898..	2, 467, 902. 00	2, 425, 510. 44	42, 391. 56
1866..	167, 787. 82	167, 787. 82		1899..	2, 829, 702. 00	2, 827, 795. 65	28, 896. 27
1867..	199, 100. 00	199, 100. 00		1900..	3, 006, 022. 00	2, 947, 603. 42	58, 418. 58
1868..	279, 020. 00	277, 094. 34	1, 925. 66	1901..	3, 304, 265. 97	3, 239, 137. 59	65, 128. 38
1869..	172, 593. 00	172, 593. 00		1902..	3, 922, 780. 51	3, 902, 875. 79	20, 104. 72
1870..	156, 440. 00	151, 596. 93	4, 843. 07	1903..	5, 015, 846. 00	4, 734, 230. 84	281, 615. 16
1871..	188, 180. 00	186, 876. 81	1, 303. 19	1904..	5, 025, 024. 01	4, 969, 311. 64	55, 712. 37

STATEMENT OF APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE.

[Fiscal years 1905 to 1916, inclusive.]

Fiscal year.	Agricultural appropriation act.			Other acts.			Total.		
	Appropriated.	Disbursed.	Unexpended.	Permanent annual appropriations, deficiency acts, special acts, and printing and binding under the sundry civil act.	Disbursed.	Unexpended.	Appropriated.	Disbursed.	Unexpended.
1905.....	\$5,902,040.00	\$5,826,365.63	\$75,674.37	\$1,207,642.62	\$1,207,642.62	.....	\$7,109,682.62	\$7,034,008.25	\$75,674.37
1906.....	6,882,690.00	6,686,510.02	196,179.98	1,955,219.96	1,955,219.96	.....	8,837,909.96	8,641,729.98	196,179.98
1907.....	9,932,940.00	9,508,845.02	364,094.98	3,146,583.98	2,310,491.66	.....	13,079,523.98	11,879,336.68	1,200,187.30
1908.....	9,447,290.00	9,279,955.36	167,334.64	3,590,512.62	3,315,546.89	.....	13,037,802.62	12,595,502.25	442,300.37
1909.....	11,672,106.00	11,478,666.40	193,439.60	4,481,428.74	4,368,528.79	.....	16,153,534.74	15,847,195.19	306,339.55
1910.....	12,995,036.00	12,647,918.27	347,117.73	4,120,374.35	4,056,552.21	.....	17,115,410.35	16,704,470.48	410,939.87
1911.....	13,487,636.00	13,184,652.22	302,983.78	7,400,813.28	7,240,115.70	.....	20,888,449.28	20,424,767.92	463,681.36
1912.....	16,900,016.00	15,530,970.55	1,369,045.45	5,502,285.11	5,454,328.84	.....	22,402,301.11	20,985,299.39	1,417,001.72
1913.....	16,651,496.00	16,005,448.40	646,047.60	8,525,668.68	8,481,328.50	.....	25,177,164.68	24,486,776.90	690,387.78
1914.....	17,986,945.00	17,297,761.46	689,183.54	6,462,879.37	6,393,232.94	.....	24,449,824.37	23,690,994.40	758,829.97
1915.....	19,865,832.00	19,408,375.18	457,456.82	6,974,602.55	6,637,656.99	.....	26,840,434.55	26,046,032.17	794,402.38
1916.....	22,971,782.00	20,388,732.68	2,583,049.32	6,047,921.98	1,931,426.17	4,116,495.81	29,019,703.98	22,320,158.85	6,699,545.13

REPORT OF THE EDITOR.

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 1, 1916.

Sir: I have the honor to submit herewith the report of the operations of the Division of Publications for the fiscal year ended June 30, 1916.

Respectfully,

JOS. A. ARNOLD,
Editor and Chief.

HON. D. F. HOUSTON,
Secretary of Agriculture.

SUMMARY.

During the year 1,038 new bulletins, pamphlets, circulars, reports, and documents were issued, the number of printed copies aggregating 29,571,739. Of this number 94 were issued through the Weather Bureau, and 944 through the Division of Publications.

The total output of documents of all kinds, new and reprints of earlier issues, aggregated 39,098,239 copies, of which 9,526,500 copies were reprints of earlier publications. The number of new department and bureau bulletins contributed by the various bureaus, divisions, and offices aggregated 168, of which 1,715,700 copies were printed. There were 62 new Farmers' Bulletins, of which there were printed 3,640,000 copies, while reprints were ordered of 284 Farmers' Bulletins, aggregating 9,155,000 copies. Thus the total number of copies of Farmers' Bulletins of all kinds printed during the year was 12,795,000. Of the serial publications, 11,682,725 copies were printed, and 9,882,621 copies of unnumbered pamphlets and separates were issued. The output of instructions, manuals, orders, Food Inspection Decisions, Notices of Judgment, circular letters, field programs, and financial statements aggregated over 2,709,600 copies. Blank books, blank forms, cards, etc., in addition to publication work proper, aggregated over 66,000,000.

The appropriation for printing and binding was \$500,000, and the amount expended was \$499,989.33, leaving a balance of \$10.67.

WORK OF THE YEAR.

The number of requisitions on the Public Printer for printing and binding of every description aggregated 4,010, as compared with 4,647 issued during the preceding year. The number of requisitions issued in 1916 on which the work was completed and delivered was 3,500, as compared with 3,995 in 1915.

Of the department's appropriation for printing and binding, not exceeding \$137,500 was provided for Farmers' Bulletins, and not exceeding \$47,000 for the Weather Bureau.

The appropriation for salaries for the 175 employees of the Division of Publications was \$174,750, and that for miscellaneous expenses \$18,750. The actual expenditures under the supervision of this division were as follows:

Printing and binding, exclusive of Weather Bureau.....	\$464, 992. 62
Salaries of employees (all on statutory roll).....	173, 399. 45
Miscellaneous expenses for materials, supplies, etc.....	17, 020. 16
Total.....	655, 412. 23

EXPENDITURES FOR PRINTING AND BINDING, 1916.

The aggregate expenditures for printing and binding were \$499,-989.33, and the following statement shows the amounts expended for the various classes of publications, and the percentage of the total amount used for each class:

Expenditures for all kinds of work and the percentage of the same to the total expenditures.

Class o. work.	Amount.	Per cent.
Farmers' Bulletins.....	\$110, 242. 49	22. 05
Publications and department bulletins.....	53, 816. 72	10. 76
Periodical publications.....	84, 913. 10	16. 98
Blank forms.....	46, 555. 19	9. 31
Congressional.....	79, 238. 56	15. 85
Miscellaneous administrative circulars, orders, decisions, etc.....	30, 324. 75	6. 07
Separates and unnumbered pamphlets.....	19, 396. 23	3. 88
Binding.....	17, 717. 39	3. 54
Index cards.....	15, 204. 61	3. 04
Blank books.....	14, 979. 39	3. 00
Letterheads.....	13, 181. 11	2. 64
Posters, placards, labels, maps, etc.....	9, 323. 84	1. 86
Compilation of laws, manuals, fiscal regulations, etc.....	5, 052. 58	1. 01
Envelopes.....	32. 45	. 01
Memoranda sheets.....	10. 92	
Total.....	499, 989. 33	100. 00

Expenditures for printing and binding for the fiscal year ended June 30, 1916, and estimated cost of work ordered but not completed.

Bureau.	Bills.	Estimates carried to 1917.	Total.
Miscellaneous (Secretary).....	\$89, 271. 48	\$3, 683. 72	\$92, 955. 20
Plant Industry.....	22, 066. 33	4, 036. 42	26, 102. 75
Bureau of Soils.....	49, 055. 14	18, 495. 13	67, 550. 27
Weather Bureau.....	34, 996. 71	3, 299. 91	38, 296. 62
Animal Industry.....	29, 673. 78	3, 120. 36	32, 794. 14
States Relations Service.....	42, 055. 47	3, 341. 36	45, 396. 83
Forest Service.....	26, 438. 53	1, 119. 96	27, 558. 49
Crop Estimates.....	25, 808. 73	2, 079. 62	27, 888. 35
Chemistry.....	11, 927. 97	1, 404. 34	13, 332. 31
Entomology.....	10, 302. 92	1, 297. 11	11, 600. 03
Library.....	9, 662. 12	757. 43	10, 419. 55
Publications.....	12, 756. 31	271. 57	13, 027. 88
Markets.....	9, 421. 62	1, 524. 64	10, 946. 26
Federal Horticultural Board.....	1, 969. 25	15. 32	1, 984. 57
Biological Survey.....	5, 290. 77	262. 87	5, 553. 64
Public Roads.....	7, 210. 11	2, 694. 01	9, 904. 12
Division of Accounts.....	855. 68		855. 68
Insecticide Board.....	983. 92		983. 92
Total.....	389, 746. 84	47, 403. 77	437, 150. 61
Farmers' Bulletins.....	110, 242. 49	7, 816. 07	118, 058. 56
Grand total.....	499, 989. 33	55, 219. 84	555, 209. 17

CLASSIFIED EXPENDITURES.

In the following statements are combined the total expenditures, by bureaus, divisions, and offices, classified according to the kind and character of the work secured, and the number of copies of each class received. While the Division of Publications does not have supervision of the appropriation for the Weather Bureau, a statement of expenditures for that bureau, being necessary to show the entire expenditure for the department's printing, is included. The total output by the department was 96,050,274 copies.

Expenditures for job work and binding and for regular publications, miscellaneous documents, circulars, and reports (arranged by bureaus, divisions, and offices) during the fiscal year ended June 30, 1916.

Bureau.	Job work and binding.	Regular publications, miscellaneous documents, circulars, and reports.	Total
Miscellaneous (Secretary).....	\$10,842.48	\$78,429.00	\$89,271.48
Bureau of Plant Industry.....	7,800.64	14,265.69	22,066.33
Bureau of Soils.....	436.02	48,619.12	49,055.14
Bureau of Animal Industry.....	19,512.43	10,161.35	29,673.78
Weather Bureau.....	16,392.90	18,603.81	34,996.71
States Relations Service.....	12,623.96	29,431.51	42,055.47
Forest Service.....	12,032.25	14,406.28	26,438.53
Bureau of Crop Estimates.....	9,722.82	16,085.91	25,808.73
Bureau of Chemistry.....	4,599.69	7,328.28	11,927.97
Bureau of Entomology.....	3,211.01	7,091.91	10,302.92
Library.....	9,310.99	351.13	9,662.12
Division of Publications.....	1,755.58	11,000.73	12,756.31
Office of Markets.....	3,525.00	5,896.62	9,421.62
Federal Horticultural Board.....	783.55	1,185.70	1,969.25
Bureau of Biological Survey.....	1,543.74	3,747.03	5,290.77
Office of Public Roads.....	1,669.45	5,540.66	7,210.11
Division of Accounts and Disbursements.....	844.09	11.59	855.68
Insecticide and Fungicide Board.....	398.30	585.62	983.92
Total.....	117,004.90	272,741.94	389,746.84
Farmers' Bulletins.....			110,242.40

Expenditures for printing and binding (arranged by bureaus, divisions, and offices) for the fiscal year ended June 30, 1916.

Bureau, division, or office.	Total.		Farmers' bulletins.		Publications and department bulletins.		Periodical publications.		Blank forms.		Congressional.		Miscellaneous administrative circulars, orders, decisions, notices, etc.		Separates and unnumbered pamphlets.	
	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.
Miscellaneous (Sec- retary).....	22, 786, 950	\$199, 513. 97	12, 795, 000	\$110, 242. 49	61, 000	\$2, 727. 80	7, 433, 200	\$45, 902. 03	1, 831, 073	\$3, 959. 63	72, 965	\$23, 588. 19	49, 200	\$3, 614. 10	46, 939	\$1, 556. 10
Bureau of Plant In- dustry.....	4, 765, 826	22, 066. 33	.....	.....	407, 000	8, 674. 55	.....	.....	1, 511, 100	2, 198. 99	1, 500	43. 97	57, 000	683. 15	498, 400	4, 854. 02
Bureau of Soils.....	201, 568	49, 055. 14	.....	.....	6, 000	548. 34	.....	.....	32, 000	81. 01	65, 300	47, 954. 81	4, 000	94. 22	5, 000	21. 75
Bureau of Animal Industry.....	16, 511, 351	29, 673. 78	.....	.....	209, 500	2, 430. 74	.....	.....	7, 677, 675	8, 387. 74	2, 500	207. 50	1, 206, 200	6, 464. 14	227, 000	1, 058. 97
Weather Bureau.....	10, 684, 172	34, 996. 71	.....	.....	5, 200	4, 938. 12	.....	.....	10, 506, 200	10, 767. 85	1, 093	4, 438. 44	3, 700	898. 81	30, 020	718. 94
States Relations Service.....	6, 925, 987	42, 055. 47	.....	.....	212, 500	4, 907. 59	.....	.....	964, 500	3, 008. 61	7, 500	2, 253. 30	1, 345, 400	7, 888. 48	66, 700	477. 22
Forest Service.....	4, 860, 270	26, 438. 53	.....	.....	147, 100	8, 300. 78	.....	.....	2, 811, 500	5, 078. 85	3, 500	171. 06	98, 050	1, 716. 06	11, 000	206. 58
Bureau of Crop Estimates.....	6, 335, 376	25, 808. 73	.....	.....	21, 000	756. 30	.....	.....	3, 097, 550	7, 415. 79	2, 500	24. 68	330, 000	467. 52	32, 000	949. 42
Bureau of Chemis- try.....	2, 796, 264	11, 927. 97	.....	.....	45, 000	1, 705. 39	.....	.....	1, 106, 220	1, 573. 83	2, 000	45. 77	485, 000	5, 237. 23	34, 900	341. 89
Bureau of Entomol- ogy.....	2, 484, 311	10, 302. 92	.....	.....	291, 500	6, 238. 84	.....	.....	185, 500	317. 74	1, 500	51. 16	5, 300	26. 43	26, 800	705. 87
Library.....	572, 622	9, 662. 12	.....	.....	.....	.....	.....	.....	153, 250	102. 40	750	51. 07	.....	.....	400	300. 06
Division of Publi- cations.....	12, 074, 388	12, 756. 31	.....	.....	.....	.....	.....	.....	672, 425	454. 05	500	85. 30	.....	.....	7, 518, 500	7, 864. 13
Office of Markets.....	2, 837, 913	9, 421. 62	.....	.....	288, 000	4, 081. 61	.....	.....	50, 550	494. 79	3, 000	164. 01	292, 500	1, 371. 34	38, 000	279. 66
Federal Horticul- tural Board.....	485, 600	1, 969. 25	.....	.....	.....	.....	.....	.....	233, 500	632. 12	2, 500	46. 02	118, 500	1, 128. 22	5, 000	11. 46
Bureau of Biologi- cal Survey.....	689, 436	5, 290. 77	.....	.....	25, 000	3, 480. 65	.....	.....	207, 600	338. 94	2, 500	42. 91	39, 000	173. 31	7, 000	50. 16
Office of Public Roads.....	716, 083	7, 210. 11	.....	.....	106, 500	5, 027. 01	.....	.....	230, 719	912. 99	2, 000	39. 90	.....	.....	.....	.....
Division of Ac- counts and Dis- bursements.....	203, 263	855. 68	.....	.....	.....	.....	.....	.....	153, 048	638. 10	200	11. 59	.....	.....	.....	.....
Insecticide and Fungicide Board.	220, 394	983. 92	.....	.....	.....	.....	.....	.....	98, 020	191. 76	2, 500	13. 88	54, 000	571. 74	.....	.....
Total.....	96, 050, 274	499, 989. 33	12, 795, 000	110, 242. 49	1, 805, 300	53, 816. 72	11, 751, 475	84, 913. 10	31, 522, 432	46, 555. 19	174, 308	79, 238. 56	4, 087, 850	30, 324. 75	8, 648, 559	19, 396. 23

Bureau, division, or office.	Binding.		Index cards.		Blank books.		Letterheads.		Posters, placards, labels, maps, etc.		Compilation of laws, manuals, fiscal regulations, etc.		Envelopes.		Memoranda sheets.	
	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.	Copies.	Cost.
Miscellaneous (Secretary).....	999	\$924.36	181,725	\$654.18	23,367	\$2,074.68	213,500	\$382.56	72,055	\$2,842.32	5,175	\$1,040.78	759	\$4.75	.....	.....
Bureau of Plant Industry.....	7,163	761.89	1,061,500	2,075.63	3,803	817.14	724,500	1,318.04	470,860	599.54	.....	.....	16,000	18.43	5,000	\$10.92
Bureau of Soils.....	1,240	94.68	12,500	75.32	.....	.....	75,000	124.51	.....	.....	.....	.....	.....	.....	.....	.....
Bureau of Animal Industry.....	73	63.30	762,573	1,627.90	93,728	5,178.27	1,470,000	1,870.26	4,761,200	2,382.98	.....	.....	.....	.....	.....	.....
Weather Bureau.....	3,072	4,426.23	9,000	30.66	237	617.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
States Relations Service.....	438	1,210.81	894,500	2,861.12	235,239	2,428.43	2,015,000	2,807.89	41,700	307.10	.....	.....	.....	.....	.....	.....
Forest Service.....	2,070	558.42	595,700	1,539.40	27,850	2,854.45	968,000	1,331.63	113,500	649.50	82,000	\$1,011.80	.....	.....	.....	.....
Bureau of Crop Estimates.....	26	53.41	507,200	1,220.82	600	23.83	552,500	1,008.97	.....	.....	.....	.....	.....	.....	.....	.....
Bureau of Chemistry.....	843	691.21	144,900	407.21	1,401	373.96	880,000	1,416.50	96,000	136.98	.....	.....	.....	.....	.....	.....
Bureau of Entomology.....	1,336	538.23	443,000	579.67	2,025	279.75	282,000	449.11	243,800	1,026.47	.....	.....	.....	.....	.....	.....
Library.....	6,972	7,866.23	367,250	1,300.01	.....	.....	24,000	37.00	20,000	5.35	.....	.....	.....	.....	.....	.....
Division of Publications.....	12,184	151.81	1,481,078	1,103.44	701	6.19	50,000	40.09	.....	.....	.....	.....	3,000	6.42	.....	.....
Office of Markets.....	25,363	189.54	593,500	1,149.60	.....	.....	1,557,500	1,647.24	6,500	37.41	.....	.....	.....	.....	.....	.....
Federal Horticultural Board.....	.....	.....	.....	23.89	.....	.....	45,000	77.04	60,000	50.50	.....	.....	.....	.....	.....	.....
Bureau of Biological Survey.....	3,078	148.50	112,400	189.70	.....	.....	150,000	262.36	143,358	604.21	.....	.....	.....	.....	.....	.....
Office of Public Roads.....	.....	.....	.....	173.50	900	125.59	234,700	370.99	11,150	66.88	.....	.....	600	2.85	.....	.....
Division of Accounts and Disbursements.....	14	16.65	104,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Insecticide and Fungicide Board.....	.....	.....	50,000	90.80	15	115.19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	64,871	17,717.39	8,381,128	15,204.61	380,050	14,979.39	9,266,700	13,181.11	7,050,076	9,323.84	87,175	5,051.52	20,350	32.45	5,000	10.92

NOTE.—The Division of Publications does not have supervision of the appropriation for the Weather Bureau. A statement of the expenditures of that bureau, however, is included in order to show the total expenditures for printing and binding for the department.

Total appropriation.....	\$500,000.00
Total expenditure:	
Exclusive of Farmers' Bulletins.....	\$389,746.84
Farmers' Bulletins.....	110,242.49
Balance.....	499,989.33
	10.67

FIXED CHARGES AGAINST THE PRINTING FUND.

There are certain fixed charges for publications against the printing fund, amounting this year to \$174,348.97, and approximately this sum must be deducted from the amount of the appropriation in order to obtain the balance available for miscellaneous reports of investigations, administrative printing, etc., which is constantly increasing. The following statement shows the fixed publications and the amount involved:

Expenditures for publications, documents, and other work regularly printed, constituting fixed charges against the appropriation.¹

Publication.	Cost for year.	Publication.	Cost for year.
Experiment Station Record.....	\$13,919.92	Soil surveys and full report.....	\$47,913.41
Journal of Agricultural Research, and separates.....	19,581.10	Expenditures, States Relations Service.....	2,207.61
Weekly News Letter.....	29,025.16	Annual Report of the Secretary.....	466.40
Department circular.....	1,342.17	Annual Reports, Department of Agriculture.....	596.80
Monthly List of Publications.....	3,051.30	Service and Regulatory Announcements.....	7,838.99
Monthly Crop Report.....	13,887.99	Annual reports.....	1,085.34
Yearbook (including separates).....	19,950.96	Statistical blanks.....	7,415.79
Field Program.....	431.32	Organization List.....	1,681.60
Directory of Bureau of Animal Industry.....	730.12		
States Relations Service Monthly.....	747.08	Total.....	174,348.97
Program of Work.....	2,475.91		

¹ No figures for the Weather Bureau are included in this table.

It was necessary during the year to hold up from publication more than 100 manuscripts of department bulletins on account of insufficient funds. The situation was so serious that a supplemental estimate of \$100,000 was submitted by the Secretary and allowed by Congress. This increase will enable the department to do considerable additional printing during the ensuing year, but it is insufficient to meet fully the requirements of the department. The amount of administrative printing, comprising blanks, blank books, instructions, regulations, decisions, etc., necessary to enable the department to execute the numerous laws for the enforcement of which the department has, during the last three years, been charged by Congress, has enormously increased, with the result that the demands on the printing fund have been large and the amount left available for printing results of the department's investigations and work has been curtailed. Of the increase granted for the current fiscal year not to exceed \$40,000 was for Farmers' Bulletins and not to exceed \$60,000 for miscellaneous printing.

STATISTICS OF PUBLICATION WORK.

The following statement shows the contributions to the department series of bulletins and the Farmers' Bulletin series by the various bureaus, divisions, and offices:

Contributions by the various bureaus to the department series of bulletins and to the Farmers' Bulletin series issued during the year.

Bureau or office.	New bulletins.	Number of copies.	Farmers' bulletins.	Number of copies.
Animal Industry.....	11	136,000	7	415,000
Biological Survey.....	4	14,000	3	205,000
Chemistry.....	3	17,000		
Entomology.....	24	82,500	21	875,000
Farm Management.....	5	31,000	2	80,000
Forest Service.....	13	118,500	2	60,000
Plant Industry.....	42	407,500	20	895,000
Public Roads.....	11	79,500	1	50,000
Soils.....	2	6,000		
Crop Estimates.....	2	16,000		
Markets.....	16	282,500	3	280,000
The Secretary.....	14	374,500		
Assistant Secretary.....			1	455,000
States Relations Service.....	20	145,500	2	325,000
Weather Bureau.....	1	5,200		
Total.....	168	1,715,700	62	3,640,000

The following statement shows the total number of publications issued during the last 27 years:

Publications of all kinds issued by the department, 1890-1916, inclusive.

Year.	Number issued.	Year.	Number issued.	Year.	Number issued.	Year.	Number issued.
1890.....	1,904,300	1898.....	6,280,365	1906.....	13,488,527	1914.....	38,186,392
1891.....	2,833,933	1899.....	7,075,975	1907.....	16,746,910	1915.....	36,075,561
1892.....	2,348,797	1900.....	7,152,423	1908.....	16,875,516	1916.....	39,088,239
1893.....	3,446,181	1901.....	7,880,281	1909.....	17,190,345		
1894.....	3,169,310	1902.....	10,586,580	1910.....	25,190,465	Total.....	404,967,582
1895.....	4,100,660	1903.....	11,698,564	1911.....	27,594,877		
1896.....	6,561,700	1904.....	12,421,386	1912.....	34,678,557		
1897.....	6,541,210	1905.....	12,475,157	1913.....	33,356,366		

THE COMMITTEE ON MANUSCRIPTS.

The committee on examination of manuscripts met twice a week or oftener during the year and made recommendations with regard to manuscripts submitted for publication and considered and reported upon such matters as were referred to it by the Secretary direct or through the assistant in charge of manuscripts in the office of the Secretary. Where the subjects were of sufficient importance chiefs of bureaus and authors met with the committee. As a result of such conferences better understanding was reached and more satisfactory publications were secured. Mr. G. W. Wharton, of the Office of Information, was added to the committee during the year.

The assistant in charge of manuscripts met regularly with the committee for the consideration of such matters as came before it. All manuscripts submitted for publication were read by him for constructive criticism and suggestions for their improvement before they were sent for printing.

FARMERS' BULLETINS.

The Farmers' Bulletins continue to be in great demand. Since the series was established in 1890, 736 bulletins have been issued, of which number 62 were issued during the year. Of earlier Farmers' Bulletins, 284 were reprinted, of which 9,155,000 copies were issued, while

3,640,000 copies were printed of new Farmers' Bulletins, making a total of 12,795,000 Farmers' Bulletins printed and distributed during the year.

Plans heretofore made for the improvement of the Farmers' Bulletins have been followed. Consideration has been given to the advisability of eliminating or revising those that are out of date or have served the purpose for which they were issued, and the preparation of new bulletins on subjects with regard to which there is now no published information.

The following is a list of the new Farmers' Bulletins issued during the year, with the editions thereof:

List of new Farmers' Bulletins issued during the year ended June 30, 1916, with the number of copies.

Num-ber.	Title.	Copies.
674	Control of the Citrus Thrips in California and Arizona.....	40,000
675	The Round Headed Apple-Tree Borer.....	60,000
679	House Flies.....	110,000
680	Varieties of Hard Spring Wheat.....	60,000
681	The Silverfish: An Injurious Household Insect.....	35,000
682	A Simple Trap Nest for Poultry.....	90,000
683	Fleas as Pests to Man and Animals, with Suggestions for their Control.....	50,000
684	Squab Raising.....	65,000
685	The Native Persimmon.....	45,000
686	Uses of Sorghum Grain.....	60,000
687	Eradication of Ferns from Pasture Lands in the Eastern United States.....	55,000
688	The Culture of Rice in California.....	35,000
689	A Plan for a Small Dairy House.....	60,000
690	The Field Pea as a Forage Crop.....	60,000
691	Grasshoppers and Their Control on Sugar Beets and Truck Crops.....	45,000
692	Game Laws for 1915.....	120,000
693	Bur Clover.....	60,000
694	The Cultivation of Peppermint and Spearmint.....	35,000
695	Outdoor Wintering of Bees.....	50,000
696	Handling and Shipping Citrus Fruits in the Gulf States.....	45,000
697	Duck Raising.....	70,000
698	Trenching Machinery Used for the Construction of Trenches for Tile Drains.....	50,000
699	Hydrocyanic-Acid Gas against Household Insects.....	30,000
700	Pecan Culture, with Special Reference to Varieties and Propagation.....	50,000
701	The Bagworm, an Injurious Shade-Tree Insect.....	45,000
702	Cottontail Rabbits in Relation to Trees and Farm Crops.....	50,000
703	Suggestions for Parcel Post Marketing.....	170,000
704	Grain Farming in the Corn Belt, with Live Stock as a Side Line.....	455,000
705	The Catalpa Sphinx.....	35,000
706	Laws Relating to Fur-Bearing Animals, 1915.....	35,000
707	The Commercial Grading, Packing, and Shipping of Cantaloupes.....	60,000
708	The Leopard Moth, a Dangerous Imported Insect Enemy of Shade Trees.....	45,000
709	Muscadine Grapes.....	50,000
710	Bridge Grafting of Fruit Trees.....	70,000
711	The Care and Improvement of the Woodlot.....	30,000
712	School Lunches.....	125,000
713	Sheep Scab.....	50,000
714	Sweet-Potato Diseases.....	30,000
715	Measuring and Marketing Woodlot Products.....	30,000
716	Management of Sandy Land Farms in Northern Indiana and Southern Michigan.....	30,000
717	Food for Young Children.....	200,000
718	Cooperative Livestock Shipping Associations.....	50,000
719	Sizes of Tractors Adapted to Different Sizes of Farms.....	50,000
720	Prevention of Losses of Stock from Poisonous Plants.....	50,000
721	The Rose Chafer: A Destructive Garden and Vineyard Pest.....	50,000
722	The Leaf Blister Mite.....	30,000
723	The Oyster-Shell Scale and the Scurfy Scale.....	30,000
724	The Feeding of Grain Sorghums to Live Stock.....	30,000
725	Wireworms Destructive to Cereal and Forage Crops.....	30,000
726	Natal Grass, a Southern Perennial Hay Crop.....	30,000
727	Growing Fruit for Home Use in the Great Plains Area.....	30,000
728	Dewberry Culture.....	30,000
730	Button Clover.....	30,000
731	The True Army Worm and Its Control.....	30,000
732	Marquis Wheat.....	30,000
733	The Corn and Cotton Wireworm in Relation to Cereal and Forage Crops, with Control Measures.....	30,000
734	Fly Traps and Their Operation.....	30,000
735	The Red Spider on Cotton and How to Control It.....	30,000
737	The Clover Leafhopper and Its Control.....	30,000
738	Cereal Crops in the Panhandle of Texas.....	30,000
739	Cutworms and Their Control in Corn and Other Cereal Crops.....	30,000
742	The White-Pine Blister Rust.....	30,000

The following statement shows the output of Farmers' Bulletins during the last 10 years, and the expenditures therefor:

Output of Farmers' Bulletins and the cost for the fiscal years, 1907-1916, inclusive.

Fiscal year.	Fund drawn upon.	Number of bulletins.	Number of copies.	Cost.
1907.....	Farmers' Bulletin fund..	235	6,469,000	\$98,601.17
1908.....	do.....	252	6,574,500	98,601.49
1909.....	do.....	271	7,755,000	122,475.48
1910.....	do.....	299	9,337,500	126,579.37
1911.....	do.....	295	9,219,000	118,012.06
1912.....	do.....	344	10,409,000.	122,753.33
1913.....	do.....	327	9,680,850	109,472.11
1914.....	do.....	339	14,960,000	136,854.75
1915.....	do.....	320	14,795,000	137,495.61
1916.....	do.....	346	12,795,000	110,242.49

The appropriation for Farmers' Bulletins was the same as for last year. \$137,500, and the same number of copies (12,500) was allotted to each Senator, Representative, Delegate, and Commissioner in Congress, as for the previous year. With the above appropriation, 12,795,000 copies of Farmers' Bulletins were secured, of which 6,479,178 copies were distributed by Senators, Members, Delegates, and Resident Commissioners in Congress. The following statement shows the output of Farmers' Bulletins during the 27 years since the series was inaugurated, with the congressional distribution for each year:

Output of Farmers' Bulletins during 27 years, with congressional distribution.

Year.	New bulletins issued.	Total number of copies printed.	Copies distributed by Congressmen.	Year.	New bulletins issued.	Total number of copies printed.	Copies distributed by Congressmen.
1890-1893.....	14	540,000	-----	1906.....	33	6,568,000	5,279,476
1894.....	5	278,500	-----	1907.....	42	6,469,000	3,484,713
1895.....	11	1,567,000	885,770	1908.....	26	6,574,500	3,928,437
1896.....	13	1,891,000	1,316,695	1909.....	34	7,755,000	3,960,642
1897.....	16	2,387,000	1,967,237	1910.....	45	9,337,500	6,449,589
1898.....	21	2,170,000	1,580,065	1911.....	48	9,219,000	5,474,079
1899.....	22	2,437,000	1,101,985	1912.....	44	10,409,000	7,851,262
1900.....	18	2,360,000	1,666,909	1913.....	42	9,680,850	5,803,088
1901.....	14	3,345,000	2,195,010	1914.....	55	14,960,000	8,399,759
1902.....	23	6,150,000	4,289,126	1915.....	77	14,795,000	7,402,072
1903.....	22	6,602,000	3,954,976	1916.....	62	12,795,000	6,479,178
1904.....	25	6,435,000	4,895,556				
1905.....	24	5,925,500	4,782,643	Total....	736	150,650,850	92,649,267

WORK OF THE WEATHER BUREAU.

In addition to the appropriation of \$47,000 for printing contained in the general printing bill, the Weather Bureau has "\$14,000 for maintenance of a printing office in the city of Washington for the printing of weather maps, bulletins, circulars, forms, and other publications," and \$45,030 for the pay of foremen, lithographers, pressmen, compositors, folders, and feeders for the printing of Weather Bureau publications that, in the judgment of the Secretary of Agriculture, can not be done at the Government Printing Office without impairing the service of the bureau. None of this work is under the supervision of this division, but under the direction of the chief of printing division of the Weather Bureau.

Since the discontinuance of the Weather Bureau series of bulletins such professional papers as can not be incorporated in the regular issues of the Monthly Weather Review are published in a series of supplements, of which No. 2, prepared during the last previous fiscal year, was issued in two parts during the present year.

In addition to its serials and periodicals, the Weather Bureau issued Part 12, Daily River Stages at River Stage Stations of the Principal Rivers of the United States for the years 1913 and 1914; Circular L, Instruction Division, Instructions for the Installation and Operation of Class A Evaporating Stations; Instructions for Special River and Rainfall Observers; Tables for Computing Time of Moonrise and Moonset; and Station Regulations. Owing to the continuance of the European war the issue of the daily weather map of the Northern Hemisphere has not been resumed since its discontinuance August 6, 1914.

The total daily, weekly, and monthly issue and disposition of periodical publications at the close of the fiscal year was as follows.

	Domestic addresses.	Foreign addresses.	Total.
Weather Map, first edition, daily.....	990	-----	990
Weather Map, second edition, daily.....	357	83	440
Monthly Weather Review.....	1,049	376	1,425
National Weather and Crop Bulletin (weekly, April to September; monthly, October to March).....	3,720	30	3,750
Snow and Ice Bulletin (weekly during winter).....	1,103	7	1,110
Climatological Data, monthly.....	239	71	310
Monthly Meteorological Summary.....	250	-----	250
Forecast cards, daily.....	1,550	-----	1,550
Forecast cards, weekly.....	240	-----	240

The above-mentioned publications were issued at Washington. Many thousands of weather maps, weather bulletins, river bulletins, cotton-region bulletins, and daily forecast cards are issued at Weather Bureau stations throughout the United States in addition to those enumerated above.

NEW FEATURES OF THE WORK.

In September, 1915, consideration was given to the nutrition publications in the series of Farmers' Bulletins, and decision reached that such bulletins should in future be published as Professional Papers in the departmental series of bulletins, and that briefer and more popularly written bulletins on the same subjects be prepared and published as Farmers' Bulletins.

The Department Circular, of which 8 numbers had been issued, was discontinued in January, 1916.

In May, 1916, the general question of the reprinting of Farmers' Bulletins received careful consideration. Heretofore these bulletins were reprinted unless objection was made by the originating Bureau. It was decided that the committee on examination of manuscripts would make a careful study of all the Farmers' Bulletins with the view to reporting upon their suitability for further distribution, with the understanding that recommendations would be made to the Secretary at the beginning of the next fiscal year. It was decided that reprints of Farmers' Bulletins should not be ordered except upon

investigation and careful consideration of the suitability of the bulletin for distribution, and after approval by the committee on manuscripts.

The Secretary having decided to make an allotment of the printing fund, each bureau, division, and office was called upon to furnish estimates of its requirements for the various classes of printing during the fiscal year 1917. These estimates were carefully considered in this division and by the committee on manuscripts under instructions to submit to the Secretary for his approval, early in the ensuing fiscal year, an equitable allotment of the appropriation of \$600,000 allowed by Congress for printing and binding for this department.

SALES OF DEPARTMENT PUBLICATIONS.

The sales of department publications by the Superintendent of Documents, Government Printing Office, continue large, notwithstanding the wide distribution of publications by the department gratis. Sales of the department's publications for the last seven years by that official, with total amounts received by him annually, are shown in the accompanying table:

Year.	Number of copies.	Amount received.	Year.	Number of copies.	Amount received.
1910.....	147,327	\$18,398.18	1914.....	231,821	\$21,708.76
1911.....	183,577	18,657.17	1915.....	335,863	23,011.10
1912.....	171,866	16,428.07	1916.....	327,381	22,277.84
1913.....	183,139	17,885.40			

Although instructions are plainly printed at the head of all lists of publications issued by this department advising applicants desiring to purchase publications to apply and send remittances to the Superintendent of Documents, Government Printing Office, still the department continues to receive many such requests accompanied by post-office money orders which this year amounted in all to \$2,808.36, requiring a careful record of the same to be made and the daily forwarding to the Superintendent of Documents of the post-office money orders so received.

WORK OF THE DIVISION BY BRANCHES.

The four branches of the work of the division are under the immediate supervision of assistants in charge, as follows: (1) Editing, B. D. Stallings, editor and assistant chief; (2) indexing, Charles H. Greathouse; (3) illustrating, A. B. Boettcher; distributing publications, Francis J. P. Cleary.

A brief statement of the operations of each branch follows:

EDITING.

This work continues to increase with the increase and development of the department.

The following table shows the number of new publications and reprints issued during the last ten years.

New publications issued, 1907-1916.

Class.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916
New publications.....	521	447	650	1,085	1,170	1,250	1,771	1,152	913	944
Reprints.....	819	998	485	462	696	643	429	474	393	357
Total.....	1,340	1,445	1,135	1,547	1,866	1,893	2,200	1,626	1,306	1,301

Manuscripts comprising 65,653 folios, with 3,934 illustrations, were read, edited, and prepared for the printer. The proof reading and revising comprised 6,872 galleys, as compared with 6,864 galleys of the previous year, and 34,598 pages in contrast to 27,916 pages for the year 1915.

It will be seen from the following table that the new numbered bulletins were 230—47 more than last year—and that, by adding the other documents which are classed as publications, the aggregate of new public documents issued under the supervision of this office was 944, or 31 more than the number reported last year. In addition to the figures contained in the table, there were 559 press notices issued from the Office of Information and the Forest Service during the year, which were mimeographed in the Division of Publications and comprised 1,104 legal-cap sheets, amounting in all to 1,819,751 copies.

Classification of the publications of the United States Department of Agriculture printed during the fiscal year ended June 30, 1916.

Character of published documents.	New.				Earlier issues reprinted.				Total.			
	Num-ber.	Pages.	Illus-trations.	Copies.	Num-ber.	Pages.	Illus-trations.	Copies.	Num-ber.	Pages.	Illus-trations.	Copies.
Miscellaneous administrative circulars, orders, decisions, notices, B. A. I. orders, directory, regulations, service and regulatory announcements, field programs, notices of judgment, food-inspection decisions, instructions to workers, circular letters, lists of workers, financial reports, notices of quarantine, etc.	197	3, 089	97	2, 484, 100	38	390	25	225, 500	235	4, 079	122	2, 709, 600
Separates and unnumbered pamphlets (Yearbook separates, separates from Journal of Agricultural Research, lists of Farmers' Bulletins, and other publications and inventories).	246	4, 280	656	9, 875, 621	4	60	19	7, 000	250	4, 340	675	9, 882, 621
Bulletins (numbered bulletins and circulars of the bureau series and department series).	168	6, 178	1, 216	1, 715, 700	31	1, 105	240	139, 000	199	7, 283	1, 456	1, 854, 700
Serial publications (Weekly News Letter, Journal of Agricultural Research, Experiment Station Record, Monthly List of Publications, Monthly Bulletins of Weather Bureau).	264	6, 941	1, 245	11, 682, 725					264	6, 941	1, 245	11, 682, 725
Congressional (Yearbook, Field Operations of the Bureau of Soils, soil surveys, annual reports, and congressional documents).	76	8, 042	546	113, 083					76	8, 042	546	113, 083
Compilation of laws, manuals, and fiscal regulations.	25	530	1	60, 500					25	530	1	60, 500
Farmers' Bulletins.	62	1, 155	473	3, 640, 000	284	7, 622	2, 803	9, 155, 000	346	8, 777	3, 276	12, 785, 000
Total.	1, 038	30, 815	4, 234	29, 571, 739	357	9, 177	3, 087	9, 526, 500	1, 395	39, 992	7, 321	39, 098, 239

INDEXING.

The work of this force has grown steadily throughout the year. The increase in the amount of indexing has been so great that it has been impossible to keep it even approximately up to date. Three large congressional documents were indexed. The book indexes heretofore made, including the indexes of the Yearbook, annual reports, and similar departmental publications, have been turned out as usual.

The indexing of new publications as they have come in, for the card indexes maintained in the room, has consumed about as much time as usual and the handling of these cards to make them available has, of course, kept pace with the making of them. The two indexes, the "available" and the "general" have been much more used during the past year than at any previous time. This is due to more general spread of notice that these indexes are available to supply lists of references to the publications of the department. Nearly all the calls for such references have come from other branches of the department.

The number of pages indexed during the past year was 33,694 against a little less than 30,000 in 1915. Of these, 44,201 were of current publications for the card cases and 9,493 for the books themselves. In addition, over 16,600 pages of the Congressional Record have been read and a considerable part indexed, against 13,127 pages last year. The Record index for department subjects has been much in use. The number of cards written was 60,290 against 61,559 last year. This includes the copies of cards to the number of from two to five made for the several indexes supplied from here.

The index for the first 500 numbers of the Farmers' Bulletins, making 432 pages, was published, in addition to several indexes for collections of Farmers' Bulletins and department bulletins when bound under one cover. A considerable amount of preparation of books for binding has been done, but there is much material on hand for preservation in the permanent sets in the vault that has not yet been bound.

A set of books, intended as permanent files, is still very insecurely kept, and it would seem advisable to put these books, held for permanent preservation, in a fireproof place with adequate shelving to make them available for examination whenever needed.

The reading of the Congressional Record and the care and distribution of documents furnished by Congress is a department that is occupying an increasingly considerable amount of working time.

ILLUSTRATING.

The number of drawings prepared by the draftsmen during the year totaled 1,887.

This showing is especially commendable when it is taken into consideration that the year's work was noteworthy for the number of drawings requiring special skill and unusual length of time to complete

Summary of drawings prepared during the fiscal year 1916.

Office of the Secretary.....	272
Weather Bureau.....	5
Bureau of Plant Industry.....	641
Bureau of Animal Industry.....	421
Forest Service.....	8

Bureau of Chemistry.....	66
Bureau of Biological Survey.....	37
Bureau of Crop Estimates.....	112
Bureau of Soils.....	2
Bureau of Entomology.....	57
States Relations Service.....	218
Division of Publications.....	34
Office of Public Roads and Rural Engineering.....	7
Office of Markets and Rural Organization.....	5
Federal Horticultural Board.....	2

Total..... 1,887

In the photographic laboratory a total of 118,441 pieces was received, as compared with 138,832 pieces during the preceding year. The decrease in production is largely due to the discontinuation of blue-print making, this branch of the work having been transferred to the Office of Public Roads and Rural Engineering early in the year.

Eighty-seven requests for photographic work were received from persons outside of the department, for which a total of \$600.40 was collected and turned over to the disbursing office.

A large number of requests were also received for duplicates of cuts of illustrations appearing in department publications. These duplicates were furnished by electrotypers at the applicants' expense.

Photographic work done for the different bureaus, divisions, and offices of the department, and for the public during the fiscal year 1916.

Bureau, division, or office.	Contact prints.	Negatives.	Films and plates developed.	Blue prints.	Bromide enlargements (76 colored).	Maps and prints mounted.	Solar bromide prints.	Lantern slides.	Lantern slides, colored.	Transparencies (3 colored).	Photostat prints.	Total.
Office of the Secretary.....	4,328	391	54	3	313	575	12	108	.....	6	1,624	7,414
Weather Bureau.....	53	12	2	.....	.....	.....	.....	.....	.....	.....	.....	67
Bureau of Plant Industry.....	31,516	1,891	2,315	281	134	1,514	388	2,055	335	4	2,653	43,086
Bureau of Animal Industry.....	11,802	1,623	451	1,537	586	927	284	2,769	166	2	2	20,149
Bureau of Chemistry.....	4,490	338	122	335	5	60	56	715	18	.....	10	6,149
Bureau of Biological Survey.....	.....	.....	.....	.....	.....	.....	7	48	49	.....	.....	104
Bureau of Crop Estimates.....	72	20	.....	.....	.....	39	65	.....	.....	.....	231	427
Bureau of Entomology.....	2,297	158	84	16	47	22	35	298	.....	.....	.....	2,957
States Relations Service.....	8,022	747	539	12	28	1,594	72	6,876	1,239	.....	5	19,134
Division of Publications.....	4,249	189	.....	.....	12	5,642	303	164	71	.....	71	10,701
Office of Public Roads and Rural Engineering.....	142	38	24	40	52	17	511	10	.....	.....	24	858
Office of Markets and Rural Organization.....	34	1,517	.....	.....	1,770	.....	8	77	.....	4	.....	3,410
Library.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	83	85
Federal Horticultural Board.....	200	1	.....	.....	.....	.....	54	17	.....	.....	.....	272
Paid orders.....	2,522	.....	.....	.....	99	54	.....	940	13	.....	.....	3,628
Total.....	69,728	6,926	3,591	2,224	3,046	10,444	1,795	14,077	1,891	16	4,703	118,441

The motion-picture laboratory, under the direction of the motion-picture committee, produced a total of 28,900 feet of negative film and 75,875 feet of positive film. It also developed 2,400 feet of negative film made elsewhere.

Of the above film, 8,475 feet of positive were used in producing and assembling subjects for other departments of the Government service, the expense being defrayed by the department interested.

Seven new films were completed for the various bureaus and offices of the department.

The greater part of the laboratory's time was used in preparing duplicate sets of existing films to be used by the department's representatives in connection with field and demonstration meetings.

DISTRIBUTION OF DOCUMENTS.

On July 1, 1915, there were in the possession of the department 7,154,950 copies of its publications. During the year just ended 39,270,865 publications were received, making 46,425,815 copies available for distribution. Of this number, 38,841,657 were distributed, leaving on hand at the close of the fiscal year a balance of 7,584,158 documents.

Under the general classification maintained in this office, the publications of the department are divided between miscellaneous documents and Farmers' Bulletins. Of the 28,642,270 miscellaneous publications available for distribution, 26,442,715 were distributed, leaving on hand on June 30, 1916, a stock aggregating 2,199,555. According to these figures, 8,769,435 more miscellaneous publications were distributed this year than last, but this increase is largely accounted for by the fact that the lists of Farmers' Bulletins distributed mostly through Congressmen and amounting to 7,500,000, were included, whereas in previous years they had been reported under a separate head.

Of the Farmers' Bulletins, the department had in its possession on July 1, 1915, 4,884,845, which, together with the 12,795,000 printed during the year made 17,679,845 available for distribution through Congressmen and to miscellaneous applicants. The total number of copies of this class distributed during the fiscal year was 12,309,742, of which 6,479,178 were distributed upon requests of Senators, Representatives, and Delegates in Congress, and 5,830,564 were sent out upon requests from miscellaneous applicants. Included in the latter were 2,222,989 ordered out by the bureaus and divisions in the department, and 568,808 sent in response to requests from schools. As compared with the figures of the previous years, this is a falling off in the distribution of Farmers' Bulletins, but when it is considered that last year 3,000,000 copies of the Agricultural Outlook, a serial publication issued in the Farmers' Bulletin series, which has been discontinued, were distributed, it will be seen that the number of bulletins on farm topics distributed this year is actually greater than that for the preceding year.

Thus it appears that the demand for Farmers' Bulletins continues unabated, and in fact is on the increase. The number used by the bureaus, offices, and divisions is rapidly increasing, caused undoubtedly in a large measure by the extension work of the Department. The large number of Farmers' Bulletins sent to schools and other educational institutions for distribution to their pupils represent really about one-tenth of the demand from that class of applicants, as it has been necessary in complying with these requests to forward only about one-tenth of the number requested and to inform the applicant that he may secure the additional copies needed from the Superintendent of Documents, Government Printing Office, Washington, D. C., or possibly through the Congressman representing his district or a Senator from his State.

The distribution work on such an enormous scale involves a great amount of clerical as well as manual labor. An important feature

of the former is the correspondence required to intelligently furnish information requested from congressional and miscellaneous sources. In fact, a congressional information service is maintained. The conduct of this correspondence required the preparation of 88,798 communications. Miscellaneous applicants forwarded 612,200 requests from all parts of the country, requiring the issuing of 535,622 orders on the Superintendent of Documents, Government Printing Office, and the addressing of 602,000 cards advising applicants at what price publications, the supply of which is exhausted, might be secured from him.

The different bureaus of the department forwarded 24,000 orders for Farmers' Bulletins, averaging somewhat less than 25 copies to the order, these documents often being used for furnishing information requested by applicants in different parts of the country.

There are 204 mailing lists, comprising 181,107 addresses, maintained in the machine room in this division.

The labor-saving devices of various kinds installed in the machine room include duplicating machines, stencil-cutting machines, folding machines, and stapling machines.

It will be seen from the summary given below that the office cooperated with eighteen other offices and bureaus of the department.

Work done in the machine rooms for the fiscal year ended June 30, 1916.

FLEXOTYPE, MULTIGRAPH, AND MIMEOGRAPH WORK.

Bureau.	Number of jobs.		Number of pages.	Number of copies.
	Flexotype and multi-graph.	Mimeograph.		
Secretary's office.....	123		170,890	131,375
Chief clerk's office.....	28	3	4,633	4,235
Solicitor's office.....	55		37,477	36,777
		5	79,960	59,910
States Relations Service.....	262		16,287	641
		3	553,100	205,500
Office of Information.....	1		14,000	7,000
		571	500	500
Bureau of Plant Industry.....	153		1,819,751	904,778
Division of Publications.....	84		610,420	528,125
Office of Public Roads.....	24	3	335,550	324,300
Federal Horticultural Board.....	91		1,500	1,500
Bureau of Chemistry.....	1,444		73,700	40,000
Biological Survey.....	66	16	147,500	123,900
Appointment clerk's office.....	3		456,870	363,330
Bureau of Entomology.....	80		49,700	5,500
Insecticide and Fungicide Board.....	23		123,600	95,250
Bureau of Crop Estimates.....	15		2,600	2,600
		5	102,024	76,692
Bureau of Animal Industry.....	19		9,675	9,025
Division of Accounts.....			92,575	92,275
Office of Markets and Rural Organization.....	4		20,700	20,700
		9	13,925	13,775
		1	21,125	12,125
			525	25
			12,150	8,100
Total.....	2,475	616	4,770,737	3,067,938

Total number pages assembled.....	769,970
Total number copies stapled.....	172,937

SUMMARY OF MISCELLANEOUS WORK.

Stencil addresses cut.....	44,868
Stencil addresses removed.....	54,009
Envelopes and franks addressed.....	5,098,333
Congressional franks cut.....	414,860
Sheets of paper cut for various bureaus.....	2,625,463
Pads made for various bureaus.....	18,797
Circulars, etc., folded.....	2,709,556

NUMBER OF STENCILS BELONGING TO THE VARIOUS BUREAUS.

Office of the Secretary.....	454
Office of Information.....	20,977
Bureau of Crop Estimates.....	89,914
Bureau of Chemistry.....	733
Bureau of Biological Survey.....	304
Bureau of Entomology.....	254
States Relations Service.....	19,136
Forest Service.....	5,478
Insecticide and Fungicide Board.....	3,496
Library.....	1,534
Federal Horticultural Board.....	3,334
Bureau of Plant Industry.....	32,524
Division of Publications.....	3,105
Office of Public Roads and Rural Engineering.....	550
Bureau of Soils.....	308
Solicitor's office.....	6
Total number of stencils.....	181,107

Below is given a summary of the work of this character done during the year:

Addresses written for different divisions.....	400,111
Miscellaneous addresses written.....	284,264
Additions to mailing lists prepared for transmission to Government Printing Office.....	170,380
Addresses carded on typewriter for General Index.....	210,380
Changes and drops ordered at Superintendent of Documents.....	50,000
Mailing circular letters and blanks for other divisions in the department..	145,874
Folding circular letters and questionnaires.....	310,016
List of Farmers' Bulletins changed from a quadruple into a single fold....	1,332,000
List of Farmers' Bulletins counted.....	1,332,000
Addresses on mailing list for Monthly List revised.....	178,000
Addresses on mailing list for Crop Report revised.....	30,000
Comparing addresses.....	300,000
Indexed addresses.....	350,000
Addresses prepared for twelve new lists maintained at the Government Printing Office.....	15,491
Service and Regulatory Announcements, Nos. 1-10, gathered and collated for binding.....sets..	500
Weekly News Letter, Vol. 2, No. 1-52, gathered and collated for binding.....sets..	100
Press notices assembled.....pages..	100,000

During the year 14,409,998 pieces of matter, or an increase of 4,456,792 over the number sent out last year, were handled here. These documents comprised pamphlets, questionnaires, and press notices, sent to employees, correspondents and collaborators of the department, and publications delivered directly to bureaus and offices in the department. Much of the matter sent out goes on a regular schedule, which at times requires much rush work in order that the publications may reach their destination upon the regular prescribed date.

The following statement shows in detail the work connected with the use of these lists for mailing various documents:

Document.	Copies.	Document.	Copies.
Monthly List of Publications.....	99,000	Crop Synopsis.....	24,000
Weekly News Letter.....	2,127,500	Corn and Gardening and Canning lists.....	64,000
Monthly Crop Report.....	152,000	Yearbooks.....	1,870
Press Notices.....	1,819,751	Field Operations of the Bureau of Soils, maps and text.....	600
Farmers' Bulletin list.....	7,500,000	Total.....	14,409,998
Publications as per scheme.....	2,409,705		
Publications to visitors in person.....	50,000		
Monthly List of Station Publications.....	14,000		

FOREIGN MAIL.

The foreign mail of the department, at least as far as its publications are concerned, continues to increase. There were forwarded to foreign countries during the fiscal year 83,973 packages of publications, weighing 30,168 pounds and 6 ounces, at a cost of \$2,295.48 in postage. This is an increase of 39,924 packages over the number sent the previous year, and of \$648.63 in the amount of postage. Included in the number of packages given above are 7,328, weighing 3,933 pounds, sent through the international exchanges of the Smithsonian Institution at the rate of 5 cents per pound, calling for an expenditure of \$196.65. The summary herewith shows a record of this work in detail:

Summary of the foreign mail for the year ended June 30, 1916.

Bureaus, divisions, and offices.	Packages requiring postage.				
	Number.	Weight.		Postage.	
		Pounds.	Ounces.	Dollars.	Cents.
Animal Industry.....	6,157	958	10	76	69
Biological Survey.....	245	77		6	16
Chemistry.....	3,342	807	12	64	62
Crop Estimates.....	3,089	453	4	36	26
Entomology.....	4,556	1,101	14	88	15
Forest Service.....	107	52	4	4	18
Journal of Agricultural Research.....	15,977	6,132	4	490	58
Library.....	18,896	6,467	6	517	39
Markets and Rural Organization.....	1,571	303	8	24	28
Plant Industry.....	5,229	1,508	14	120	71
Publications.....	10	15	8	1	24
Roads and Rural Engineering.....	687	131	2	10	49
Secretary's office.....	2,704	711	12	56	94
Soils.....	83	20	8	1	64
States Relations Service.....	13,992	7,493	12	599	50
Total.....	76,645	26,235	6	2,098	83
Total for fiscal year 1915.....	33,309	17,140	10	1,371	25
Increase during fiscal year 1916.....	43,336	9,094	12	727	58

Summary of the foreign mail for the year ended June 30, 1916—Continued.

Bureaus, divisions, and offices.	Packages sent through the international exchanges.				Total.				
	Num-ber.	Pounds.	Value.		Num-ber.	Weight.		Postage.	
			Dol-lars.	Cents.		Pounds.	Ounces.	Dol-lars.	Cents.
Animal Industry.....	586	259	12	95	6,743	1,217	10	89	64
Biological Survey.....	203	96	4	80	448	173	.....	10	96
Chemistry.....	3	2	.....	10	3,345	809	12	64	72
Crop Estimates.....	849	411	20	55	3,938	864	4	56	81
Entomology.....	1,552	842	42	10	6,108	1,943	14	130	25
Forest Service.....	304	188	9	40	411	240	4	13	58
Journal of Agricultural Research.....	8	5	.....	25	15,985	6,137	4	490	83
Library.....	1,877	1,020	51	.....	20,773	7,487	6	568	39
Markets and Rural Organization.....	128	67	3	35	1,699	370	8	27	63
Plant Industry.....	1,100	557	27	85	6,329	2,065	14	148	56
Publications.....	10	5	.....	25	20	20	8	1	49
Roads and Rural Engineering.....	380	205	10	25	1,067	336	2	20	74
Secretary's office.....	130	96	4	80	2,834	807	12	61	74
Soils.....	104	50	2	50	187	70	8	4	14
States Relations Service.....	94	130	6	50	14,086	7,623	12	606	.....
Total.....	7,328	3,933	196	65	83,973	30,168	6	2,295	48
Total for fiscal year 1915.....	10,740	5,510	275	50	44,049	22,650	10	1,646	75
Increase during fiscal year 1916....	(1)	(1)	(1)	(1)	39,924	7,517	12	648	73

TOTAL PACKAGES SENT ABROAD DURING FISCAL YEAR 1916.

Item.	Packages.	Pounds.	Ounces.	Dollars.	Cents.
Packages to which postage was affixed.....	76,645	26,235	6	2,098	83
Packages sent through the international exchanges, Smithsonian Institution.....	7,328	3,933	.....	2 196	2 65
Grand total.....	83,973	30,168	6	2,295	48

¹ Decrease in packages sent through the international exchanges, Smithsonian Institution: 3,412 packages, 1,577 pounds, \$78.85.

² The Smithsonian Institution is reimbursed from the department's contingent fund at the rate of 5 cents per pound.

REPORT OF THE CHIEF OF THE BUREAU OF CROP ESTIMATES.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CROP ESTIMATES,
Washington, D. C., September 15, 1916.

SIR: I have the honor to submit herewith the report of the Bureau of Crop Estimates for the fiscal year ended June 30, 1916.

Respectfully,

LEON M. ESTABROOK,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

PERSONNEL.

During the fiscal year ended June 30, 1916, the total number of permanent salaried employees in the Bureau of Crop Estimates was 149, of whom 105 were stationed in Washington, D. C., and 44 were stationed in the field. In addition to the regular force in the Washington office it was found necessary to employ from three to nine temporary clerks and skilled laborers for from three to six months, near the close of the year, in order to handle the greatly increased volume of work, the number of schedules mailed and sorted having increased from 1,264,154 for the fiscal year 1915 to 1,989,718 for the fiscal year 1916, or an increase of 57.4 per cent.

The total number of voluntary crop reporters and special correspondents who served without compensation was approximately as follows:

Township.....	30, 220	Potato.....	4, 766
County.....	2, 777	Peanut.....	3, 882
County aids (estimated).....	5, 554	Comparative price.....	796
Field aids.....	15, 639	Broom corn.....	1, 029
Special price.....	5, 932	Live stock.....	6, 284
Apple.....	8, 764	Mills and elevators.....	9, 104
Cotton crop specialist.....	520	Individual farm.....	32, 486
Individual farm, cotton.....	8, 086	Maple sirup.....	1, 200
Special cotton.....	5, 226	Truck crop specialist.....	6, 500
Sheep.....	6, 453		
Bee.....	2, 775		
Cranberry.....	335	Total.....	158, 310

ADMINISTRATIVE OFFICE.

The administrative office of the bureau, under the direct supervision of the chief of bureau, the assistant chief of bureau, and the chief clerk, effected various improvements in methods of filing bureau records, keeping account of bureau finances and property, and in supervising and facilitating the work of the office and field force, as well as directing activities of the bureau and looking after the increased volume of correspondence.

DIVISION OF CROP REPORTS.

The work of the Division of Crop Reports, with the field force under the direct supervision of Mr. S. A. Jones, chief of division, increased nearly 60 per cent during the fiscal year 1916, the total number of schedules and circulars handled by the division amounting approximately to 2,000,000. This increase was largely due to the rapid growth of the truck crop investigations and to numerous special inquiries relating to minor crops and to particular phases of staple-crop and live-stock production. The work of this division consists mainly in the preparation of crop schedules several months in advance of their use, the mailing out of schedules to the field agents and voluntary crop reporters, the opening, sorting, and classifying of the returned schedules, the editing, checking, tabulating, adding, and averaging of the returns, the maintenance of lists of crop and special voluntary reporters, and the inspection of the work and records of the field agents. The data collected and compiled by this division form the basis of the monthly and special crop reports of the bureau.

DIVISION OF CROP RECORDS.

This division, under the direct supervision of Mr. Frank Andrews, chief of division, has charge of the official records of crop estimates concerning the United States from Federal, State, and private sources, and agricultural statistics of foreign countries. The records have been compiled from published and unpublished reports in such a way as to show in concise and convenient form information that is given in the original reports in a more or less scattered way, usually in a long series of reports and frequently in foreign units of weight and measure. In every case units of foreign weight and measure have been converted to the equivalent American units. Statistical records relating to agriculture have been completed for 11 principal foreign countries and show acreage and production of crops, numbers of different classes of live stock, etc., from the earliest to the latest years for which available. In addition to the 11 countries, about half of the record for Russia is complete. Estimates of United States crop production, as made by State officials and private parties, have been segregated and entered on record practically as soon as received in the division. When the compilation of agricultural statistics for the remaining countries is finished, probably within the next year or two, the Bureau of Crop Estimates will have the most complete record of estimates and statistics relating to world crops and live stock in existence, all expressed in terms of American units and in such convenient form as to be immediately available for reference.

Reports on the sugar crop of the United States and Hawaii are compiled in this division. These reports are based upon actual enumerations, and in this respect are an exception to the general crop-reporting system of the bureau. During the year four reports were made relating to beets and beet sugar, namely, acreage planted, tonnage of beets sold by farmers, preliminary estimate of beets produced and sugar made, and after the close of the season a final estimate of beet and sugar production. Two reports were made on the Louisiana sugar industry, one in December, giving the estimated tonnage of cane to be used for sugar and a final report giving the annual production of sugar, as well as the tonnage and acreage of cane used. One report was made for the Hawaiian industry, giving the final figures for acreage and production of cane and the production of cane sugar. The first annual report on maple sugar was planned and completed in this division, based upon data tabulated in the Division of Crop Reports.

As supplementary to the bureau's estimates of Durum wheat production the Division of Crop Records made its tenth annual estimate of the total exports of Durum wheat from the United States, which was based upon reports received from various commercial agencies and transportation companies.

A large number of special compilations were made for the Secretary, the Assistant Secretary, other branches of the department, Senators and Representatives in Congress, and other persons interested in agricultural statistics. A series of charts were made showing for each State the annual changes in acreage for each principal crop from 1866 to 1915, inclusive. The average yield per acre for each principal crop for 1915 was computed by counties. This completes a five-year record of average yields by counties.

MONTHLY CROP REPORTS.

During the year the bureau issued estimates of the numbers, prices, and value of different classes of live stock; losses from disease and exposure, number of breeding sows, and the number of stock hogs compared with last year.

Acreage estimates were made in June for barley, oats, spring wheat, clover hay, and sugar cane; in July for corn, rice, potatoes, sweet potatoes, cotton, flaxseed, sorghum, and tobacco; in August for buckwheat, rye, hay (tame hay, wild hay, and total); in September for clover seed, and in December for rye and winter wheat. Acreage remaining after abandonment was estimated for winter wheat and rye in May and for cotton in December.

Monthly during the crop season estimates were made of the condition of the growing crops as a percentage of normal for cereals, including barley, buckwheat, corn, oats, rice, wheat (spring and winter), forage, including alfalfa hay, alfalfa for seed, bluegrass for seed, Canadian peas, clover for hay, clover for seed, cowpeas, hay (tame hay, wild hay, and total), kafir, meadows, millet, pasture, and timothy; fruits, including apples, apricots, blackberries, cantaloupes, cranberries, grapefruit, prunes, raspberries, strawberries, and watermelons; vegetables, including dry beans, lima beans, velvet beans, cabbages, cauliflower (California), celery (California), onions, potatoes, sweet potatoes, and tomatoes; miscellaneous, in-

cluding almonds (California), broom corn, cotton, flaxseed, hemp, honey, hops, peanuts, percentage of planting done, percentage of plowing done, sorghum, sugar beets, sugar cane, tobacco, English walnuts (California), and wool.

Yield per acre was estimated in August for clover hay and pounds of honey per colony; in October for alfalfa seed, cabbages, onions, broom corn, hemp, and hops; in November for clover seed, kafir, cranberries, peanuts, and sorghum; and in December for all principal crops for which acreage estimates are made. During the growing season the condition reports, expressed as a percentage of normal for all crops for which acreage is estimated, were interpreted in yield per acre as a forecast of production.

The percentage of a full crop produced was estimated in April for celery in California; in May for cauliflower in California; in July for strawberries; in August for clover hay, blackberries, and pineapples (California); in September for alfalfa hay, bluegrass seed, apricots (California), cantaloupes, peaches, and watermelons; in October for alfalfa seed, Canadian peas, kafir, millet, prunes (California), dry beans, lima beans, cabbages, onions, tomatoes, broom corn, and hemp; in November for clover seed, cowpeas, kafir, apples, cranberries, grapes, pears, lemons (California), peanuts, English walnuts (California), and wool.

Farm prices of all crops and live stock were estimated monthly.

Final estimates of acreage, yield and total production, were made in December for barley, buckwheat, corn, oats, rice, rye, hay, potatoes, sweet potatoes, flaxseed, cotton, and tobacco.

The percentage of the corn crop cut for silage was estimated in November.

The percentage of the crop of merchantable quality was estimated in March for corn.

The percentage of crops shipped out of counties where grown was estimated in March for barley, corn, oats, and wheat.

The quality of crops produced was estimated in August for rye, winter wheat, and clover hay; in September for tame and wild hay and peaches; in October for barley, oats, spring wheat, and hops; in November for buckwheat, corn, apples, cranberries, pears, potatoes, sweet potatoes, flaxseed, peanuts, and tobacco; in December for grapefruit (Florida), lemons (California), and oranges.

Supplies on farms were estimated in March for barley, corn, oats, and wheat; in May for hay; in July for wheat; in August for barley and oats; and in November for corn.

The value and weight per bushel were estimated in July for wool, and for barley, oats, winter wheat, and spring wheat.

SPECIAL REPORTS.

In addition to the monthly crop reports the following reports were prepared for issuance to the press or for publication in the Monthly Crop Report:

Corn:

Amount of 1914 corn crop cut for silos, cut green for forage, and matured for grain.

Quality of corn and degree of maturity at first killing frost.

Comparison of maturity of 1915 corn crop with usual year.

Percentage of 1915 corn crop, white, yellow, and mixed.

Wheat:

Percentage of winter wheat thrashed August 1.
 Winter wheat yields and thrashing done to September 1.
 Graphic presentation of receipts of wheat weekly at primary markets.
 Stocks and disposition of wheat on March 1.
 Wheat inspection at Chicago.
 Farm movement and prices of wheat by months.
 Wheat held by country mills and elevators.
 Wheat unfit for milling.
 Wheat crop estimates and movement compared.
 Production of Durum wheat.

Cotton:

Price paid to producers of cotton and percentage of crop sold by months.
 Disposition of 1914 cotton crop by producers per month.
 Long-staple cotton; yield per acre, percentage of different lengths, total production, and price per pound.
 Cotton-crop estimates and ginnings compared.
 Purchases of commercial fertilizers for the 1915 cotton crop.

Tobacco:

Tobacco estimates by types and districts.

Hay:

Wild hay production.
 Hay crop by varieties.

Truck crops:

Acreage of vegetables contracted for by canners.
 Truck condition, issued monthly during growing season.
 Commercial-bean production.
 Dry-bean estimates.
 Beans and peas—varieties, yield, and disposition.
 California cabbage and onion prospects.
 Early southern truck, condition and dates of harvesting; several reports.
 The onion crop.
 The cabbage crop—varieties, amount harvested, disposition, and acreage grown for kraut manufacture.
 Early potato acreage.
 Stocks of potatoes on January 1.
 Florida truck acreage.
 The Texas Bermuda onion crop.
 Acreage in watermelons and cantaloupes in 1915 and 1916.
 Condition of truck crops for canning.
 Diversification of crops in the South.
 Cranberry production.
 Strawberry acreage.

Apples:

The apple crop by varieties.
 Apple crop production.
 Apples harvested by months.
 Apple production and value by varieties.
 Distribution and value of last year's apple crop.

Maple sugar and sirup: Production and trend of sugar and sirup prices.

Honey bees: Report.

Live stock:

Graphic presentation of monthly variation of live-stock prices.
 Prices of meat animals.
 Trend of prices of meat animals.
 Prices of live stock by ages or classes.
 Milk production in the United States.
 Yearly marketing of live stock, 1900-1915.
 Wool production in 1915.
 Variation in the monthly supply of swine.
 Percentage of hogs slaughtered on farms per month.
 Condition and losses of farm animals.
 Causes and extent of live-stock loss.

Prices:

Range of prices of agricultural products at important markets.
 Farm sales of crops and live stock.

Prices—Continued.

Monthly sales from farms.

Graphic presentation of monthly variation of crop prices.

Farm value of important products in January, 1915.

Clover-seed prices.

Prices of articles purchased by farmers.

Values:

Estimated total value of farm products for 21 years.

Aggregate crop value comparisons.

Value of farm lands.

Value per acre of farm lands.

Graphic presentation of proportion of important crops produced in leading five States in 1915.

INTERNATIONAL INSTITUTE OF AGRICULTURE.

Seventeen regular reports on crops of the United States were made by cable and mail to the International Institute of Agriculture at Rome, Italy. In addition to printed reports issued by the institute, there were received during the year fourteen cablegrams relating to crop production in the adhering countries of the world, which were interpreted and presented to the press through the Office of Information.

PUBLICATIONS.

Twelve numbers of the Monthly Crop Report were issued during the year, aggregating 136 quarto pages of estimates and agricultural statistics.

Two hundred and two statistical tables were prepared for publication in the Department Yearbook for 1915.

A department bulletin dealing with our foreign trade in farm and forest products was published.

A report of the Office of the Secretary on the meat situation in the United States was printed.

A graphic summary of American agriculture, which was published in the 1915 yearbook of the department, was prepared in cooperation with the Office of Farm Management.

LIBRARY.

The library of the Bureau of Crop Estimates, which is a branch of the library of the department, during the fiscal year received approximately 300 foreign and 300 domestic periodicals containing useful information regarding agricultural statistics. Of these periodicals about 160 were monthly, 150 weekly, 48 daily, and the remainder were issued at other periods. The total number of separate copies of periodicals received was about 30,000.

The books in the library comprise the agricultural reports of practically all countries issuing such reports; also a fairly complete collection of the official reports of exports and imports for each foreign country. The collection of State reports on agriculture and live stock is practically complete; also annual statistical reports of commercial agencies, such as boards of trade, chambers of commerce, cotton exchanges, etc. Efforts were made during the year to supply what was lacking from this class of publications.

ACCURACY OF COTTON CROP ESTIMATE.

Cotton is the only crop for which there is an absolute check on the estimates of the Bureau of Crop Estimates. On December 10, 1915, the bureau estimated the 1915 cotton crop at 11,161,000 bales of 500 pounds each. The Bureau of the Census, Department of Commerce, is required by law to report every bale of cotton ginned, and at the close of the season the census showed 11,059,000 running bales, equivalent to 11,183,000 bales of 500 pounds (including 39,000 bales estimated yet to be ginned after March 20, 1916), as having been ginned from the 1915 crop. The estimate of the Bureau of Crop Estimates, issued more than three months previously, was only 22,000 bales too low on the entire crop, or less than one-fourth of 1 per cent.

IMPROVEMENT IN ORGANIZATION AND EQUIPMENT FOR ESTIMATING CROP AND LIVE-STOCK PRODUCTION.

Methods of improving the crop-reporting service are constantly under consideration in the Bureau of Crop Estimates. As pointed out in the previous annual reports of this bureau, the most difficult problem encountered in crop reporting is an attempt to estimate acreages planted to different crops and the numbers of different classes of live stock on farms; also such special crops as truck and fruit. To take an annual census of acreages and live stock can not be considered because of the enormous expense involved and the time required to compile and publish the results. Returns of local tax assessors in the various States are not always complete, uniform, or available when needed. In lieu of an annual census enumeration the best substitute appears to be an organization or system of reporting for definite areas under the constant observation of field agents who are trained in crop-reporting methods, supplemented by reports of large numbers of individual farmers distributed throughout each area, and by reports of trained specialists on each crop. This in effect is the system at present employed by the Bureau of Crop Estimates. Obviously, the smaller the territory assigned to each field agent, or what means the same thing, the greater the number of field agents assigned to a given territory, the more thoroughly the acreages and condition of crops and the numbers of different classes of live stock can be studied, and the more satisfactory will be results. That better results can be secured from a smaller division of territory has been fully demonstrated since the bureau has had a trained field agent in each of the principal agricultural States, instead of one agent for a group of States, as formerly. However, it is evident that even a single State in the important producing areas is entirely too large for one man to cover effectively.

If sufficient funds were available to fully develop and perfect the crop-reporting service it would be highly desirable to give the field agent in each State one or more trained assistants, so that the State could be divided into districts and a survey made of its agricultural resources and production by counties. It would also be desirable to provide the field agent in each State with a clerk to assist in folding and mailing schedules of inquiry, opening and tabulating returns,

and in handling correspondence and other necessary office work, so as to relieve the field agents of the burden of routine details and leave them free to devote their entire time to the more important and difficult work of studying, analyzing, estimating, and forecasting crop conditions and prospects.

The purchase of at least 30 automobiles would be especially desirable. Crop estimates can not be made entirely from written reports of correspondents, nor can the field agent judge of the condition and probable yield of a crop from the fleeting glance he gets through a car window when speeding across the country between cities and towns. During the growing season, especially at critical periods in the life history of a crop, field agents must get out in the fields and examine individual plants. The greater the number of fields examined the more accurate will be the field agent's judgment of the extent of damage from various causes. At the present time field agents travel from town to town by rail or trolley and at each point it is usually necessary to hire a conveyance to go out in the country. Trains run at irregular intervals and it is often difficult to obtain a conveyance at stopping points. The agent can inspect only a small territory in the vicinity of a town and often loses much time waiting for trains. The use of automobiles by agents would obviate many of these difficulties and by enabling the field agent to visit crop-producing areas not readily accessible by railway, with power to stop at any point en route to examine particular fields, would increase the efficiency and dependability of the service manyfold.

It is highly desirable also that the clerical force in Washington should be increased in order to handle properly the increased number of returns from the field force and to meet the increasing demands which are constantly being made upon the bureau for special investigations. Irrespective of whether the field force is increased, the desirability of a substantial increase in the clerical force of the bureau is becoming more and more apparent. During the past decade the volume of work to be done has nearly doubled and is likely to increase as the agriculture of the country develops and as interest grows in the production and consumption of agricultural products. The fact that the crop-reporting service has been able to meet the increasing demands upon it with its present inadequate force is due largely to the cooperation of public-spirited men in every community who serve as voluntary crop reporters without monetary compensation, and to the loyal and efficient service of employees in the field and in the Washington office, who cheerfully work outside of the customary office hours and on Sundays and legal holidays when necessary to tabulate returns in order to get the crop reports out promptly.

REPORT OF THE LIBRARIAN.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE LIBRARIAN,
WASHINGTON, D. C., *September 14, 1916.*

SIR: I have the honor to submit herewith the executive report of the library for the fiscal year ended June 30, 1916.

Respectfully,

CLARIBEL R. BARNETT,
Librarian.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

USE OF THE LIBRARY.

A noteworthy feature of the past year's work was an increase of 12 per cent in the use of the library. This year for the first time a count was made of the number of the library's registered borrowers. The count showed that there were 1,530 individuals in the department who borrowed books either through the main library or the branches in the various bureaus, divisions, and offices. To 711 of these registered borrowers current periodicals were circulated regularly. It is impracticable to keep any record of the reference use of the collections filed in the main library or of those filed in the bureaus, divisions, and offices. Furthermore, circulation statistics are not kept in all the libraries of the bureaus, divisions, and offices. Therefore, the statistics of circulation given in the following tables express inadequately the real use of the library. The total number of books charged to individuals, 56,141, added to the total circulation of current periodicals, 127,885, making a grand total of 184,026, represents the use of the library in so far as this can be shown by the statistics which are kept. The total number of books circulated divided by the number of registered borrowers of books gives an average for the year of 36 to each borrower. The total number of current periodicals circulated divided by the number of registered borrowers to whom they are regularly sent, gives an average of 179 issues to each borrower.

STATISTICS OF CIRCULATION.

The following table indicates the growth in the work of the circulation division of the main library during the past four years:

Statistics of circulation (main library), fiscal years 1913, 1914, 1915, and 1916.

	1913	1914	1915	1916
Largest number of books charged on any day.....	203	214	268	248
Smallest number of books charged on any day.....	31	39	37	57
Average number of books charged daily.....	121	126	134	160
Largest number of books charged in any month.....	4,106	4,454	4,260	5,028
Smallest number of books charged in any month.....	2,269	2,083	2,567	3,077
Average number of books charged monthly.....	3,078	3,239	3,412	4,076
Total number of books charged during the year.....	36,933	38,879	40,953	48,911

Books and periodicals charged by the main library and the bureau, division, and office libraries during the fiscal years 1915 and 1916.

	Number of books charged.								Number of periodicals charged.	
	To individuals.		To main library.		To branch libraries.		Total.			
	1915	1916	1915	1916	1915	1916	1915	1916	1915	1916
Main library ¹	16,067	14,996	.....	.....	24,886	33,918	40,953	48,914	(²)	(²)
Bureau of Animal Industry: ⁴										
Dairy division.....	1,930	1,909	58	56	19	38	2,007	2,003	14,839	12,820
Biochemic, pathological, zoological and other divisions.....	(³)	(³)	(³)	(³)	(³)	(³)	(³)	(³)	(²)	19,409
Bureau of Chemistry..	9,373	9,751	817	765	61	17	10,250	10,533	20,032	19,244
Bureau of Entomology..	2,765	4,680	366	446	68	104	3,193	5,230	1,003	1,292
Forest Service.....	3,697	3,550	436	369	3	.....	3,314	3,919	4,268	4,548
Bureau of Plant Industry.....	11,688	14,930	595	979	148	180	12,431	16,099	40,318	43,275
Office of Farm Management.....	2,753	3,462	3	.....	2	.....	2,758	3,462	6,652	7,802
Office of Markets and Rural Organization..	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	19,495
Office of Public Roads and Rural Engineering.....	1,540	2,863	168	178	33	12	1,741	3,053	(²)	(²)
	49,723	56,141	2,437	2,793	25,220	34,269	76,647	93,213	87,112	127,885

¹ Statistics include circulation in all bureaus and offices not mentioned below.

² No records kept.

³ Circulation statistics included in statistics of main library.

⁴ No bureau library is maintained. The statistics of circulation of books are included in those of the main library.

INTERLIBRARY LOANS.

In addition to the use of the library in the department, books are lent to libraries and institutions in and out of Washington. There were 15 libraries, institutions, and Government departments in Washington which made use of the library's resources during the past year. The records of books lent to institutions outside of Washington are given in the following table, from which it will be seen that, with three exceptions, books were lent last year to every State in the Union. The number of different institutions to which they were lent was 91, and in addition 9 business firms and 5 individuals made use of the Library, making a total of 105 different borrowers from outside of the city. To the total number of books lent, namely, 1,240, should be added 129 photostat copies and 9 typewritten copies of articles which were furnished, making the total use outside of the city 1,378. The installation during the latter part of the year of a photostat machine in the Division of Publications for the general use of the department makes it easier now for the library to have photostat work done, as it was formerly obliged to rely upon the generosity of one of the bureaus for this work. Whenever the articles in periodicals requested for use outside of Washington are short enough to warrant it and the copyright laws allow it, photostat copies are made instead of sending the books. In this way the possibility of the book's being needed in the department while it is outside of the city is avoided. The number of books requested which were not contained in the Library was 175. The number which could not be supplied because they were in use or at the bindery was 59. In addition, 27 could not be supplied because the references could not be identified.

Record of books lent outside of Washington during the fiscal years 1912 to 1916.

States, etc.	Fiscal year.					States, etc.	Fiscal year.				
	1912	1913	1914	1915	1916		1912	1913	1914	1915	1916
Alabama.....			3	3		New Mexico.....		1	4	3	9
Arizona.....	8	7	6	4	14	New York.....	79	59	113	142	127
Arkansas.....	1			2	3	North Carolina.....	25	35	30	48	17
California.....	15	19	27	26	50	North Dakota.....	4	6	11	3	11
Colorado.....	15	9	12	27	24	Ohio.....	37	53	103	78	29
Connecticut.....	12	16	4	4	2	Oklahoma.....			1		
Delaware.....	8	11	18	11	10	Oregon.....	36	54	44	51	66
Florida.....	38	27	20	44	21	Pennsylvania.....	27	34	19	21	29
Georgia.....	7	1	14	15	37	Rhode Island.....			1	6	2
Idaho.....		3	5	9	5	South Carolina.....	2	5	1	1	22
Illinois.....	2	6	12	7	66	South Dakota.....	2			3	
Indiana.....	23	7	7	25	20	Tennessee.....	9	16	26	20	31
Iowa.....	9	36	24	63	80	Texas.....	12	10	9	23	11
Kansas.....	18	8	12	59	71	Utah.....				8	17
Kentucky.....	2	6	4	25	7	Vermont.....		27	30	21	9
Louisiana.....		5	2	2	10	Virginia.....	50	52	54	32	26
Maine.....		7	11	8	22	Washington.....	13	3	14	8	11
Maryland.....	9	12	7	25	28	West Virginia.....	14	10	2	12	16
Massachusetts.....	10	14	18	36	25	Wisconsin.....	32	89	31	38	41
Michigan.....	20	37	35	22	37	Wyoming.....		5		4	5
Minnesota.....	5	2	7	64	78	Canada.....	11	2		1	
Mississippi.....	3	4	3	4		Hawaii.....	1	2	2		
Missouri.....	5	17	19	18	15	Porto Rico.....	33	39	67	57	43
Montana.....	2	15	13	5	15	Canal Zone.....			1		
Nebraska.....	17	32	20	20	18	Alaska.....					2
Nevada.....					3						
New Hampshire.....		8	5	3	2	Total.....	620	826	896	1,196	1,240
New Jersey.....		1	24	83	53						

During the last half of the fiscal year, as a matter of interest, an informal record was kept of the number of letters from outside of the city received each day requesting interlibrary loans. It was found that with the exception of 21 days, at least one request was received every day and that the average was over 2 a day, the total being 362 for the 6 months.

As in previous years, the department has continued to make large use of the resources of other libraries. A comparative statement of this use during the past four years is shown in the following table:

Summarized statement of books borrowed from other libraries during the fiscal years 1913 to 1916.

Item.	1913	1914	1915	1916
Largest number of books borrowed from other libraries on any day.....	43	40	42	42
Average number of books borrowed from other libraries daily.....	18	16	18	23
Largest number of books borrowed from other libraries in any month.....	731	564	579	734
Average number of books borrowed from other libraries monthly.....	480	432	460	571
Number of books borrowed during the year from libraries outside of Washington.....	91	62	58	86
Number of books borrowed during the year from other libraries in Washington.....	5,677	5,166	5,463	6,774
Total number of books borrowed from other libraries in and out of Washington.....	5,768	5,228	5,521	6,860

It will be noted from the above table that the number of books borrowed from libraries outside of the city has not increased in the past four years, but that the number borrowed from libraries in the city has increased between 18 and 19 per cent. Of the 6,774 borrowed from libraries in the city during the past year, 5,279 were borrowed from the Library of Congress, 939 from the Surgeon General's library, 227

from the National Museum and Smithsonian Institution, 92 from the Geological Survey, 48 from the Weather Bureau, 45 from the Hygienic Laboratory, 43 from the Bureau of Education, 33 from the Public Library, 29 from the Patent Office, 13 from the Bureau of Fisheries, 5 from the Department of Commerce, 4 each from the Children's Bureau, Bureau of Labor Statistics, and the Bureau of Railway Economics, 3 from the Bureau of Ethnology, and 2 each from the Department of State, Bureau of Standards, and the Army War College. Of the 86 borrowed from libraries outside of the city, 14 were borrowed from the Arnold Arboretum, and the remaining 72 from 23 other libraries. Often the search for a book needed by the department involves writing to a number of libraries before it is finally found. To all libraries which have generously aided the department in its work by lending books from their collections, special thanks are due.

ACCESSIONS.

The number of books, pamphlets, and maps added to the library during the past fiscal year, compared with the accessions of the four previous years, is as follows:

Accessions to the library for the fiscal years 1912, 1913, 1914, 1915, and 1916.

Accessions.	1912	1913	1914	1915	1916
Purchases:					
Volumes.....	1,552	1,321	1,548	1,353	1,595
Pamphlets.....	77	51	41	39	49
Maps and charts.....		1	1		13
Photographs.....	10				
Serials and continuations.....	522	459	511	376	274
Total.....	2,161	1,832	2,101	1,768	1,931
Gifts:					
Volumes.....	907	886	719	780	873
Pamphlets.....	756	830	470	500	397
Maps.....	20	28	20	22	18
Continuations.....	3,560	4,425	4,490	4,909	4,919
Total.....	5,243	6,169	5,699	6,211	6,207
From binding periodicals and serials.....	*1,718	1,573	1,826	1,085	1,612
Total.....	9,122	9,574	9,626	9,064	9,750

According to the record of accessions, the total number of books and pamphlets accessioned by the library up to July 1, 1916, was 143,685. From this number should, however, be deducted 5,910 volumes which were discarded during the fiscal year 1915 and 72 which were discarded during the present year, leaving a balance of 137,703 books and pamphlets in the library on July 1, 1916.

The library, in common with all other libraries, has suffered from the European war. It has interfered seriously with the purchase of books from continental booksellers and as a result little progress was made in the past year in completing imperfect sets of periodicals and in filling the gaps in the collections. On account of the difficulty of obtaining books from the continental countries, there have been unusually large accessions of books and periodicals in the English language.

Special mention should also be made of the large number of Japanese books, reports, and periodicals purchased by the library in the

past year, the selection being made by Mr. W. T. Swingle on the occasion of his visit to Japan in connection with his work for the Bureau of Plant Industry. The most important item in the collection was a complete set of the Botanical Magazine of Tokyo, which, as far as is known, is the only complete set owned in the United States. The large number of Japanese agricultural experiment station reports also acquired, combined with those received in the past year or two in exchange for the Experiment Station Record and the Journal of Agricultural Research, have very materially increased the library's collections of the agricultural experimental work of foreign countries.

With the growth of the department it is necessary to purchase an increasing number of duplicates, especially dictionaries, atlases, and directories. The amount spent for duplicates last year was \$2,471.61, as compared with \$1,902.26 the previous year.

In spite of the difficulty of obtaining exchanges from foreign countries during the war, the total number of gifts and exchanges received was only slightly less than the number received in the previous year, due largely to the fact that an arrangement was made during the past year whereby certain American and foreign periodicals and lists noting material on subjects of interest to the department are now regularly examined by members of the staff of the main library and the branch libraries for material to be obtained by gift and exchange.

PERIODICAL DIVISION.

LYDIA K. WILKINS, *Chief.*

The total number of different periodicals (exclusive of annuals and serials of infrequent issue) received currently during the year was 2,280, of which 834 were received by purchase and 1,446 by gift. The number of new periodicals added during the year was 334, whereas 391 of those on last year's list are no longer received either because they have ceased publication permanently or temporarily, or because the subscriptions for them have been discontinued. There was a net decrease for the year of 57. In order to facilitate the circulation of some of the periodicals, it was necessary to purchase 164 duplicates, making the total number of periodicals purchased 998. Of the periodicals received by gift and exchange, over 571 duplicates were received, making the total number of periodicals handled currently during the year 3,015.

The abnormally large number of periodicals, namely, 391, which were received in the fiscal year 1915, but not during the present year, is due principally to the war. A large majority of these are foreign and are only temporarily suspended. Many of them also are no doubt still being published, but on account of the interrupted mail and freight service can not be forwarded. There has been great delay in the delivery of all foreign periodicals and many files have been broken, but it is hoped that they may be completed when normal conditions exist.

The distribution of the current periodicals by classes is shown in the accompanying table. In addition to the above current periodicals appearing not less than four times a year, the library received 5,106 serials of less frequent issue, such as annuals, annual reports, proceedings, and transactions published by institutions and societies.

The circulation of the current periodicals has increased to such an extent that many of them are injured by much handling. The need

has therefore been felt for some time of mending and protecting them. Special arrangements were accordingly made in the past year by the main library in cooperation with the branch libraries for mending those which have suffered in circulation and for reinforcing those which are not well made or have long circulation lists. As a result of these efforts there has recently been a marked improvement in the condition of the periodicals in circulation.

Statistics of current periodicals.¹

	Purchase.	Gift.	Total.		Purchase.	Gift.	Total.
Agriculture, United States...	14	182	196	Flour and feeding stuffs....	11	9	20
Agriculture, foreign.....	29	193	222	Ice and refrigeration.....	3	7	10
Veterinary medicine.....	27	30	57	Paper.....	10	1	11
Dairying.....	13	27	40	Printing.....	1	2	3
Poultry and pigeons.....	5	44	49	Instruments.....	2	.....	2
Live stock and meat trade..	7	48	55	Photography.....	7	1	8
Soils and fertilizers.....	3	6	9	Physics.....	5	1	6
Drainage and irrigation.....	1	.....	1	Meteorology.....	1	1	2
Farm implements and machinery.....	3	12	15	Chemistry and chemical technology.....	79	20	99
Moor culture and peat.....	2	3	5	Food.....	10	19	29
Agricultural products.....	33	49	82	Home economics.....	3	4	7
Fibers and textiles.....	4	8	12	Pharmacy.....	16	14	30
Horticulture and landscape gardening.....	41	56	97	Geology and mineralogy.....	3	5	8
Forestry.....	18	36	54	Natural history.....	8	34	42
Experiment station publications, United States.....	.....	109	109	Zoology.....	20	11	31
Experiment station publications, foreign.....	1	28	29	Hunting and fishing.....	10	8	18
General.....	8	9	17	Ornithology.....	10	5	15
Bibliography and library economy.....	18	22	40	Entomology.....	36	13	49
Education, including agricultural extension.....	3	74	77	Beekeeping.....	7	4	11
Economics and sociology.....	17	23	40	Microscopy.....	4	.....	4
Commerce and statistics.....	98	110	208	Biology.....	16	5	21
Groceries.....	3	4	7	Medicine, physiology, and hygiene.....	54	49	103
Engineering.....	22	8	30	Bacteriology.....	9	1	10
Building.....	7	5	12	Botany.....	54	21	75
Roads.....	2	11	13	General science.....	18	43	61
Railroads.....	14	10	24	Geography.....	1	10	11
Manufactures.....	31	14	45	Law.....	10	.....	10
				United States Government documents.....	2	37	39
				Total.....	834	1,446	2,280

¹ Annual reports, proceedings, and transactions not included.

DUPLICATES.

As in previous years the library received a large number of duplicates of publications of States, foreign Governments, societies, and institutions. Three lists of these duplicates were prepared by the Periodical Division and sent to the Library of Congress and to libraries of the State agricultural colleges. The items selected from these lists filled 71 mail sacks.

CATALOGUE DIVISION.

HELEN M. THOMPSON, *Chief.*

There were classified and catalogued 2,468 volumes, 446 pamphlets, 6,805 serials and continuations, and 31 maps and charts, making a total of 9,750, an increase of 686 over the preceding year. In addition to the complete cataloguing of the above books, pamphlets, and maps, author cards were made for 796 pamphlets and 2,057 "reprints." The pamphlets for which only author cards are made are those of less importance. They are arranged by subject in a separate pamphlet collection. The "reprints" or "separates" of articles from periodicals are also filed in a separate collection which is ar-

ranged alphabetically by author. There were added to the main (dictionary) catalogue 25,980 cards, and 4,357 were withdrawn, making the net addition 21,623, an increase of 1,888 as compared with the preceding year. It is estimated that the main (dictionary) catalogue now contains approximately 347,300 cards.

The number of titles prepared by the library for printing by the Library of Congress in what is known as the "Agr" series of catalogue cards, compared with the fiscal years, 1912, 1913, 1914, and 1915, is as follows:

Titles prepared for printing catalogue cards.

	1912	1913	1914	1915	1916
Cards for accessions and recatalogued books.....	1,872	1,357	1,248	786	947
Cards for department publications.....	449	807	676	646	485
Cards for foreign agricultural periodicals.....	61	298	141	65	54
Total.....	2,382	2,462	2,065	1,497	1,486

The total number of titles prepared by this library since 1902, in which year the printing of cards was begun, is 28,534.

The amount of uncatalogued material on hand July 1, 1916, was as follows: 190 volumes, 381 pamphlets, and 89 continuations.

During the past year a revised edition of the classification of the library was printed. This third edition was made necessary by reason of the great number of changes and additions made in the classification since the publication of the second edition (1906) and because the supply of the second edition was entirely exhausted. Considerable progress was made during the year in reclassifying certain classes to correspond with the new classification, but there is much work still to be done.

BINDING.

FANNY L. PARKER, *in Charge.*

The number of books and periodicals sent to the Government Printing Office for binding was 3,363, a decrease of 469 as compared with the previous year. This decrease was due in part to a lack of funds for binding and in part to the fact that less assistance was available for the preparation of the books for the bindery. In addition to the books and periodicals permanently bound, 1,689 were laced in temporary binders. No record was kept of the large number of reports, single numbers, etc., added to volumes already in temporary binders, nor of the number of pamphlets stapled in pamphlet binders.

BIBLIOGRAPHICAL AND REFERENCE WORK.

During the past year work was begun by the main library in cooperation with the bureau, division, and office libraries, in indexing the articles by department scientists appearing in nondepartmental publications since April, 1913. This index supplements the record of the department's work as shown by the printed cards for department publications.

The work of the libraries of the Bureau of Plant Industry, the Bureau of Entomology, the Dairy Division, and the Office of Mar-

kets and Rural Organization in revising the bibliographical lists accompanying the publications of their respective bureaus and offices has been continued. In addition, an assistant in the Bureau of Plant Industry library has continued to revise all bibliographical lists accompanying the papers for the Journal of Agricultural Research.

The list of books and articles indexed by the Forest Service library is still printed each month in *American Forestry*. The library has also prepared during the year a number of special bibliographies on forestry subjects, the longest being on the forest conservation movement in the United States, and a list of Forest Service publications issued up to November 15, 1915.

In the Bureau of Entomology library a bibliography on insects as food is being prepared and the index to articles on insects in department publications continued.

In the library of the Office of Grain Standardization a bibliography on gluten and protein in wheat and wheat flour has been revised and a bibliography on future trading, hedging, and speculation in grain and cotton transactions prepared.

In the Bureau of Chemistry library a compilation was made of foreign laws requiring chemical and physical tests to be applied to imported food products before entry into a country, and of those requiring that imported food products be accompanied by certification from the country of origin. A list of references was also compiled to articles which have appeared during the past five years on the importance of mineral or inorganic salts in the diet.

In the States Relations Service library progress has been made in bringing up to date a manuscript revision of the List of Publications of the State Experiment Stations. It is hoped that this work may be printed. Under the assignment to the States Relations Service of the administration of the Smith-Lever Act, relating to cooperative agricultural extension work, the library of the Service began the collection of the extension publications of the institutions cooperating with the United States Department of Agriculture under this act. A check list, on cards, of these publications is in progress.

In the Office of Farm Management library short lists on the farmer's income, cost accounting, and the cost of crop production were prepared. A bibliography on farm management in the United States is in preparation.

In the Office of Markets and Rural Organization a bibliography on the marketing of farm products was prepared and issued in multigraphed form.

In the main library work was continued on the index to the State agricultural reports. About one-third of the reports have been indexed. Numerous bibliographical lists varying in length from 10 to 55 items were prepared in answer to requests received in correspondence. The most extensive list was on the subject of farm tenancy. During the past year the library has also received an increased number of requests for the verification of bibliographical references.

Work has been continued on the index and bibliography of the literature of maize, a project of the Office of Crop Acclimatization in the Bureau of Plant Industry, with which the library is cooperating. The index now contains approximately 18,000 entries.

AFFILIATED ACTIVITIES.

In addition to the regular library work performed by the main library and the bureau, division, and office libraries, mention should also be made of other activities not ordinarily considered as a part of library work.

As has been noted in previous reports, the library has general supervision of the foreign mailing lists of the various bureaus, divisions, and offices, and has charge of the miscellaneous distribution of the publications of the department sent as exchanges to foreign countries. The obvious reason for having this work done in the library is its importance as an exchange section of the accessions division, which is thereby able to know what publications of the department are being sent to foreign countries and what publications may be legitimately expected in exchange. The library maintains a consolidated list, arranged geographically, of all the addresses appearing on the various bureau and office foreign mailing lists. This list comprises at the present time 3,195 addresses. The care of the mailing lists, the ordering of the department publications sent as exchanges, and the correspondence involved in the work require a very considerable amount of the library's time. Some of the bureau libraries also are called upon to do work in connection with the distribution of their bureau publications, namely, the libraries of the Bureau of Plant Industry and the Bureau of Entomology. As the domestic mailing lists of the Bureau of Plant Industry are extensive, the care of the lists is an important part of the work of the library of that bureau. During the past year improvements were made in the routine of the distribution of publications and the handling of the mailing lists, resulting in a more consistent, economical, and effective distribution of the bureau publications.

An important feature of the work of the library of the Office of Markets and Rural Organization, aside from the regular library work, is the editing of the publications of the office.

Another activity of the main library which should be mentioned is the translating. Last year 248 letters and 4 articles were translated. Translations are furnished from the following languages: German, French, Spanish, and Italian.

All of the bureau, division, and office libraries are called upon to do more or less other miscellaneous work not strictly library work. This is often an advantage, as the librarians are thereby enabled to come in closer contact with the work of the bureaus. Their familiarity with indexing and bibliographical tools and their training in classification not infrequently fit them also for the compilation of data of various kinds and the systematic arrangement of printed and other material.

LIBRARY STAFF.

The number of employees carried on the roll of the main library at the close of the year was 33, the same as the previous year; the number employed by the bureau, division, and office libraries was 37, an increase of 4 over the previous year. The total number, 70, employed in the main library and the bureau, division, and office libraries, includes 53 librarians, library assistants, and stenographers, 15 messengers, and 2 charwomen. The only change in the personnel

of bureau librarians was in the Bureau of Crop Estimates. The former librarian, Miss Louise Hayward, resigned in September, 1915, and was succeeded by Miss Helena C. Spraker.

LIBRARY MEETINGS.

Library staff meetings were held each month from October, 1915, to March, 1916. At the December meeting a talk on the work of the department was given by the Assistant Secretary of the department. At the January meeting Mr. W. T. Swingle gave a talk entitled "Bibliographic notes on a recent trip to Japan and China." The other meetings were devoted to discussions by the members of the Library staff. Special attention was paid to the subjects of binding and mending and the systematic acquisition of free material.

The Library was represented at the annual conference of the American Library Association in Asbury Park, N. J., in June, by the Librarian of the department, the librarian of the Bureau of Entomology, the assistant librarian of the Bureau of Chemistry, and two assistants from the main library.

BUREAU, DIVISION, AND OFFICE LIBRARIES.

The work of the branch libraries in the bureaus, divisions, and offices was carried on along lines similar to the work of previous years and there were no changes in organization.

The Bureau of Chemistry library was moved from rooms on the fourth floor to rooms on the second floor, since the crowded condition of the bureau made it necessary to reduce the space for the library.

For the quarters of the Bureau of Plant Industry library an additional room was provided in the past year. This additional space was needed on account of the growth of the work in connection with the mailing lists of the bureau.

The libraries of the Bureau of Chemistry, the Forest Service, and the Bureau of Plant Industry have charge of the records in connection with the purchase of books and periodicals for the field laboratories and stations of their bureaus; that is, for the laboratories and stations located outside of Washington. During the past year 294 volumes and 1 map were purchased for the field laboratories and inspectors of the Bureau of Chemistry at a cost of \$1,178.80. About \$2,000 was spent for books and periodicals for field libraries of the Forest Service, which now number 176. There are 93 field-station collections in the Bureau of Plant Industry, containing a total of 1,900 volumes; the periodicals subscribed for by the bureau for use in the field stations number 224. Books and periodicals for filing in laboratories and stations outside of Washington are paid for from the funds of the bureaus by which the laboratories and stations are maintained.

The following table shows the approximate number of books and pamphlets contained in the various bureau, division, and office libraries, the number of current periodicals which are sent to them regularly for review or filing, the number of registered borrowers, and the number to whom periodicals are regularly circulated. The statistics in regard to the use of the books in the various libraries and an account of the bibliographical work and other activities are given on preceding pages of this report.

Books, pamphlets, and periodicals in bureau, division, and office libraries.

Bureau or office.	Librarian in charge.	Number employed.	Number of books and pamphlets.	Number of periodicals currently received.	Number of registered borrowers.	Number of registered borrowers to whom periodicals are circulated.
Bureau of Animal Industry ¹ .	Miss Jessie Urner.....	1	² 2,306	² 167	29	29
Animal Husbandry Division.						
Dairy Division.....	Miss Margaret Doonan	3	2,290	303	50	50
Biochemic, Pathological, Zoological, and other divisions.	Miss Elsie Moore ³	1	(⁴)	353	89	69
Bureau of Biological Survey.	Mr. W. H. Cheesman ⁵	1	² 6,000	67	27	23
Bureau of Chemistry.....	Miss Anne E. Draper	3	6,600	446	213	99
Bureau of Crop Estimates...	Miss Helena C. Spraker	2	² 10,000	600	30	-----
Bureau of Entomology.....	Miss Mabel Coleord	1	15,089	266	158	-----
Bureau of Plant Industry...	Miss Eunice R. Oberly	10	² 4,000	774	360	140
Forest Service.....	Miss Helen E. Stockbridge.	2	18,852	130	120	42
Office of Farm Management.	Miss Cora L. Feldkamp	3	8,276	219	58	36
Office of Markets and Rural Organization.	Miss Caroline B. Sherman.	3	1,875	289	133	96
Office of Public Roads and Rural Engineering.	Miss Grace Francis....	1	² 6,800	137	80	25
Office of the Solicitor.....	(⁶)		² 1,700			-----
States Relations Service....	Miss E. Lucy Ogden..	6	4,300	628	79	53

¹ No Bureau Library is maintained.² Approximate figures.³ Periodical assistant.⁴ No separate library collections maintained.⁵ Editor and librarian.⁶ No librarian in charge.

FINANCES.

A comparison of the receipts and expenditures of the library for the last five years is given in the following table:

Financial statement, fiscal years 1912 to 1916.

RECEIPTS.

Source of receipts and object of expenditure.	Fiscal year.				
	1912	1913	1914	1915	1916
Source:					
Library appropriation.....	\$40,500.00	\$41,280.00	\$43,520.00	\$45,360.00	\$46,020.00
Allotment from department printing and binding fund.....	12,813.95	13,843.31	11,345.84	10,190.62	9,662.12
Total.....	53,313.95	55,123.31	54,865.84	55,550.62	55,682.12

EXPENDITURES.

Object:					
Books and serials.....	\$7,290.95	\$6,825.71	¹ \$9,100.00	¹ \$8,512.15	¹ \$9,117.24
Periodicals.....	3,694.00	3,606.48	¹ 4,232.41	¹ 3,511.18	¹ 4,154.11
Index cards.....	146.89	215.86	168.03	181.56	161.15
Supplies and repairs.....	150.32	313.27	556.93	384.55	384.80
Furniture, shelving, and miscellaneous equipment.....	1,000.20	2,643.89	904.73	3,112.18	699.67
Traveling expenses.....	97.98	29.52			31.20
Salaries (main library).....	27,848.17	27,140.27	28,377.17	29,585.50	31,278.06
	40,228.51	40,775.00	43,339.28	45,287.12	45,826.23
Printing.....	3,307.54	4,084.21	1,892.25	1,895.47	1,806.79
Binding.....	9,506.41	9,759.10	9,453.59	8,295.15	7,855.33
	12,813.95	13,843.31	11,345.84	10,190.62	9,662.12
Total.....	53,042.46	54,618.31	54,685.12	55,477.74	55,488.35

¹ Approximate figures.

From the total \$7,855.33 spent for binding in the past year, \$7,148.45 was spent for regular binding, \$573.46 for binders, and \$103.42 for pamphlet boxes. From the \$1,806.79 spent for printing, \$51.07 was spent for the printing of the annual report of the librarian for 1915, \$300.06 for the printing of the new edition of the classification, \$205.66 for forms, and \$1,250 for the cards printed, through the Library of Congress, for the publications of the department and for the accessions.

A. L. A. FORM FOR LIBRARY STATISTICS.¹

Annual report for year ended June 30, 1916.

Name of library, U. S. Department of Agriculture Library.

City or town, Washington, D. C.

Terms of use: Free for lending to department employees; free for general reference.

Total number of agencies, 14 (consisting of main library and 13 branches).

Number of days open during year, 306.

Hours open each week for lending, 45 for 9 months; 41½ during 3 summer months.

Hours open each week for reading, 45 for 9 months; 41½ during 3 summer months.

Total number of staff, 33 in main library, 37 in branches.

Number of volumes added during year by purchase, 1,595.

Number of volumes added during year by gift and exchange, 873.

Number of volumes added during year by binding material not otherwise counted, 1,612.

Number of volumes withdrawn during year, 72.

Number of pamphlets added during year, 446.

Number of serials added during year, 5,193.

Number of maps and charts added during year, 31.

Total number of books and pamphlets, 137,703.

Total recorded use, 184,026.

Number of interlibrary loans, 1,378.

Total number of registered borrowers, 1,530.

Number of periodicals currently received, 2,280 titles; 3,015 copies.

FINANCE.

RECEIPTS.		PAYMENTS FOR—	
Government appropriation...	\$46,020.00	Books.....	\$7,017.58
Allotment from department		Periodicals.....	4,154.11
printing and binding fund..	9,662.12	Other serials.....	2,099.66
		Salaries, library service.....	31,278.06
		Printing and binding.....	9,662.12
		Other maintenance.....	1,276.82
Total.....	55,682.12	Total.....	55,488.35

¹ Libraries which print their annual reports are requested by the American Library Association to include therein their statistics presented according to a form compiled by the A. L. A. Committee on Library Administration. This very greatly facilitates comparison. The statistics of the library are given above in the A. L. A. form in so far as the records kept by the library make it possible.

REPORT OF THE DIRECTOR OF STATES RELATIONS SERVICE.

UNITED STATES DEPARTMENT OF AGRICULTURE,
STATES RELATIONS SERVICE,
Washington, D. C., June 30, 1916.

SIR: I have the honor to present herewith the report of the States Relations Service for the fiscal year ended June 30, 1916.

Respectfully,

A. C. TRUE, *Director.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

INTRODUCTION.

The States Relations Service was organized July 1, 1915, in accordance with the authority granted to the Secretary of Agriculture in the agricultural appropriation act of 1915-16, and his order contained in memorandum No. 140 of the Secretary's office, which included the following provisions:

The States Relations Service shall include the following offices: (1) The office of the director of the service, which shall include those officers and employees engaged in the general work and administration of the service; (2) the Office of Experiment Stations, including the work of the service relating to agricultural experiment stations; (3) the Office of Extension Work in the South, including the farmers' cooperative demonstration work and the Smith-Lever agricultural extension work in 15 Southern States; (4) the Office of Extension Work in the North and West, including the farmers' cooperative demonstration work and the Smith-Lever agricultural extension work in 33 Northern and Western States; and (5) the Office of Home Economics, including investigations relative to foods, clothing, and household equipment and management.

The work of the service relating to agricultural instruction and to farmers' institutes and similar organizations shall be under the immediate direction of the director, and the work relating to farmers' institutes and similar organizations shall be carried on in close cooperation with the offices of extension work.

The States Relations Service will take under consideration matters relating to all the extension work carried on by the several bureaus and offices of the department and those connected with the administration of the Smith-Lever Extension Act. All plans for demonstration and extension work originating in any bureau or in any State should first be submitted to the States Relations Service, which will make recommendations regarding them to the Secretary. Approved plans for demonstration and extension work by any bureau should not be put into operation in any State until they have been brought to the attention of the Director of the States Relations Service and an opportunity has been given for arranging with the extension directors of the agricultural colleges regarding the execution of these plans in the States concerned.

OFFICE OF THE DIRECTOR.

The Service, in which has been brought together the administrative and advisory work of the Department in its relations with the State agricultural colleges and experiment stations has already demonstrated its usefulness in strengthening and coordinating those relationships. Naturally the chief attention has thus far been given to the organization and administration of the cooperative extension work, since this was a comparatively new line of work in which the methods of operation of the State institutions and the different branches of the department had in many respects not been fully developed or standardized. The proper content and scope of extension work in agriculture and home economics under Federal and State legislation had not been defined or even considered in any thorough way. Many questions of public policy, meaning of various words and phrases in the laws, methods of cooperation with department bureaus, State colleges, and other institutions, county governments and organizations, private organizations, and individuals, etc., have had to be considered and passed on. The far-reaching character of the agricultural extension movement had not been clearly apparent even to those who had been most intimately associated with it and even now there are a multitude of matters connected with it regarding which we are still feeling our way. Apparently much progress has been made in settling the general lines of work and in shaping the methods of cooperation. The public system of cooperative agricultural extension work is now operating in all the States. Headquarters and agents for the work have been located in over 1,200 counties. Federal, State, county, and local agencies are actively cooperating with a large measure of harmony and effectiveness, and on a broader scale than ever before. Many organizations and individuals have contributed to this result.

Those branches of the Service which have dealt with the experiment stations, the agricultural schools and farmers' institutes, and the investigations in home economics have continued to work in much the same ways as heretofore and with comparatively few changes in personnel.

The organization of a new Service with large forces and funds has necessarily caused a relatively great elaboration of the general administrative office. Attention is therefore briefly called to the present functions of the different branches of the Director's office as they have been developed during the past year.

To aid the Director in the examination of project and budget statements and financial reports, the preparation of correspondence and reports for the Director's or Secretary's signature, the coordination of the work of different branches of the Service, and to keep such record of projects, budgets, reports, rulings, conferences, and other administrative matters as are required in the Director's office, an administrative assistant has been employed.

The organization of the Service, with a force now aggregating about 2,300 employees as compared with about 250 in the former Office of Experiment Stations, has necessitated a large measure of reorganization and enlargement in the offices of the chief clerk and the chief accountant. The changing character and great increase of

the force and funds employed in the cooperative extension work, owing to the complicated relations with the contributing State colleges and county organizations, has increased many fold the clerical work involved in appointments and other papers affecting personnel and in the accounting work of the Service. The work in handling property and supplies has at least doubled. As far as possible consolidation and coordination of work in these lines have been effected in the central offices with a view to preventing duplication of work in the different branches of the Service. The location of our Washington force in different buildings necessarily prevents the most complete economy in the management of the routine business.

Library and bibliographical work in connection with Experiment Station Record on the literature of agricultural science and experimentation has been continued and similar work on the literature of extension work in agriculture and home economics has been inaugurated. For general agricultural and scientific literature the Service depends entirely on the Library of the Department, with which it works in close cooperation. Until a year ago the only publications permanently located in the Service were those of the State agricultural experiment stations, the collection of which was begun by the Office of Experiment Stations soon after the passage of the Hatch Act. A similar collection of extension publications issued by the institutions receiving the benefits of the Smith-Lever Act is now being made. Every effort has been made to make and keep these collections as complete as possible and beginning with January 1, 1916, a subject index to these extension publications has been kept on cards for the use of the extension offices of the States Relations Service located in Washington. Books and periodicals of interest to their work have been brought to the attention of these offices and some work has been done at their request in preparing bibliographical lists on specific subjects. Similar service is given to the editors of the Experiment Station Record in calling to their attention or procuring for them on request books and periodicals giving the result of agricultural experimentation and scientific investigation in agriculture and related subjects. Progress has been made in bringing up to date a manuscript revision of the list of publications of the State experiment stations originally issued as Bulletin 180 of the Office of Experiment Stations. This list, even in manuscript form, is invaluable in answering inquiries that come to this Service, is much used by workers in other bureaus of this Department, and portions of it have occasionally been lent to institutions outside of Washington.

EDITORIAL DIVISION.

W. H. BEAL, *Chief.*

This division deals in an editorial capacity with all the publications of the States Relations Service, except the Experiment Station Record. It represents the Director in his relations with the Division of Publications and the Committee on Examination of Manuscripts and has charge of the mailing lists, lantern slides, charts, and other illustrative material of the Service.

The Service issued during the year 92 documents, aggregating 3,830 pages. These included 19 numbers of Experiment Station Record, 5 reports, 9 technical bulletins, 1 article in Journal of Agricultural Research, 4 insular station publications, 2 Farmers' Bulletins, 3 Yearbook articles, 2 syllabi of farmers' institute lectures, 9 numbers of Agricultural Education Monthly, 9 numbers of Farm Demonstration Monthly, 22 documents on cooperative demonstration work, and 7 miscellaneous documents.

Much progress was made in consolidating and cataloguing the collection of lantern slides and photographs belonging to the Service, securing new illustrative material from the different bureaus, improving and standardizing the quality of illustrative material used in the Service, organizing and developing a chart service, and regulating the shipment of lantern slides for use in farmers' institutes, schools, and extension work. About 1,000 shipments, aggregating over 44,000 slides, were made during the year.

INVESTIGATIONS ON AGRICULTURAL INSTRUCTION IN SCHOOLS.

C. H. LANE, *Chief Specialist in Agricultural Education.*

In 17 States agriculture is now required by law to be taught in all public rural elementary schools, and in 7 States it is put into the required course of study prescribed by the State superintendent of public instruction. In a considerable number of States agriculture is required in the rural high schools and in urban elementary schools.

During the past year there was an unprecedented increase in the number of secondary schools giving agricultural courses. Reports to this effect have been received from 4,665 schools, and the number of students in such courses rose to over 90,000. A large number of agricultural college graduates are in charge of these courses, the use of land for instructional purposes has greatly increased, and many of these schools have introduced the home-project method as a practical feature of agricultural instruction. The development of the boys' and girls' clubs as a feature of the cooperative agricultural extension work is also being taken advantage of by many schools as an aid to their classroom instruction in agriculture.

Many new problems have arisen regarding the content and methods of agricultural instruction and the relations of this work to other subjects in the curriculum. Not only the State departments of education and the local school authorities and teachers but also the agricultural colleges are giving much more attention to these problems and are seeking the aid of the Bureau of Education and the Department of Agriculture along these lines. Their needs are in two general lines: (1) Information regarding the organization of agricultural instruction in the United States and foreign countries and assistance in the formulation of courses of study suited to different agricultural regions, and (2) well-organized subject matter in the various branches of agriculture, based on the results of the work of this department and the agricultural experiment stations.

In the first line this Service has during the past year entered into a larger measure of cooperation with the Bureau of Education. In addition to continued cooperation in the preparation of an annual

report on the progress of agricultural education at home and abroad, for publication by that bureau, there has been united study of the methods of organization and administration of instruction in agriculture in the public schools, the training of teachers for this work, and the relationships of the different agencies promoting such instruction. Three cooperative conferences on the problems of teacher training in the agricultural colleges have been held in different parts of the country and attended by representatives of the colleges, the State departments of education, and other leaders in this work. In this way tentative courses for teacher training have been worked out for testing in the State institutions, with a view to standardizing the requirements for the licensing of teachers of agriculture by the State authorities.

In work on the preparation of publications and illustrative material for use in the schools substantial progress has been made during the past year in perfecting arrangements with the different bureaus, by which we get the advice and assistance of specialists in various lines of agricultural research. It has developed that most effective work can be done by having in the service persons trained in agriculture and the methods of education who are able to prepare the material intended for school use on the basis of the publications of the department and the stations, supplemented with the advice of specialists regarding details. Attempts are therefore being made to differentiate the functions of the members of the force along the lines of elementary and secondary instruction as related to different subject-matter divisions of agriculture.

The series of bulletins on elementary agriculture for the rural schools, begun last year in cooperation with some of the State agricultural colleges and State departments of education, has resulted in the issuing of such bulletins for the schools of Maryland and Wisconsin. Similar work has been completed for the schools of Mississippi and a bulletin for the rural schools of Vermont is in process of preparation. Other publications issued during the year dealt with lessons in elementary agriculture for Alabama schools, correlating agriculture with the public school subjects in the Northern States, lessons on cotton for the rural common schools, exercises with plants and animals for southern rural schools, and home projects in secondary courses in agriculture. A publication dealing with the methods of instruction in soils in land-grant colleges is in process of preparation, and a manuscript was prepared dealing with lessons on tomatoes for rural schools.

Nine numbers of the *Agricultural Education Monthly* were issued, dealing, among other things, with such subjects in secondary agricultural instruction as methods of teaching agriculture in secondary schools, use of illustrative material in secondary schools, a simple method of cataloguing agricultural literature suitable for the school or home library, professional improvement for teachers of agriculture, and definite outlines of lessons in a number of agricultural subjects.

The Service began during the year the preparation of brief pedagogical statements on how to use, in the teaching of agriculture in rural schools, certain *Farmers' Bulletins*. Eight of these leaflets have been issued.

At the request of the Mississippi State Department of Public Instruction the Service has begun the adaptation of the four units of agriculture outlined for the accredited high schools in the South to the Mississippi county agricultural schools.

The problem in agricultural education studied in cooperation with the Association of American Agricultural Colleges and Experiment Stations was the relation of the work in agriculture in secondary schools to college courses in agriculture.

Special studies of the problems of visual instruction in agriculture were begun and some additional sets of lantern slides were prepared for instructional purposes. One set, worthy of special note, deals in detail with school garden work in connection with teacher training in a normal school, featuring how this work may be correlated with such subjects in the course of study as arithmetic, drawing, and language.

INVESTIGATIONS ON FARMERS' INSTITUTES AND MOVABLE SCHOOLS.

J. M. STEDMAN, *Farmers' Institute Specialist.*

Farmers' institutes are conducted by the State departments of agriculture in 24 States and by the agricultural colleges in 24 States. The colleges are bringing their institutes into close relations with their other extension work and making them more largely demonstrational and educational. In the States where they are not under the management of the colleges there is also a growing tendency to fit them into the extension movement by cooperative arrangements with the colleges or otherwise. The attendance at the institutes in the United States last year aggregated about 3,000,000.

Information regarding the institutes throughout the country was collected and published during the past year as hitherto.

The preparation of syllabi of lectures on agricultural and home economics subjects, illustrated by appropriate sets of lantern slides, was continued. Illustrated lectures were completed during the past year on the production of alfalfa east of the one hundredth meridian, cattle tick eradication, orchard management, corn production, and how to make good farm butter for the South. Some of those formerly published have been revised and brought down to date. These lectures are used not only by farmers' institute lecturers, but also by county agricultural agents, extension workers in agricultural colleges and schools, teachers of agriculture and home economics in rural schools, etc. About 23,800 slides were loaned to nearly 500 applicants during the past year and over 100 applications were refused because of the limited supply of slides.

Courses of instruction to be used by self-instructed classes in movable schools were prepared on soils and vegetable foods.

In cooperation with the Office of Extension Work in the North and West a study of the practical effects of county agent and farmers' institute work was made in two counties by personal visitation of a large number of the farmers residing there.

OFFICE OF EXPERIMENT STATIONS.

E. W. ALLEN, *Chief.*

As a part of the States Relations Service this office is charged with the business connected (1) with the department's relations with the State agricultural experiment stations, including the supervision of the funds and work under the Federal appropriations, the preparation of the abstract journal Experiment Station Record, now in its twenty-seventh year, and of the card index of experiment station literature, and (2) with the management of the Federal experiment stations in Alaska, Hawaii, Porto Rico, and Guam. Minor functions relate to the assistance of the institutions in securing suitable experts for their various lines of work, the looking up of literature on special subjects relating to their investigations, and keeping a record of the organization and progress of experiment stations throughout the world.

RELATIONS WITH THE STATE AGRICULTURAL EXPERIMENT STATIONS.

The relations between the office and the experiment stations in the various States continued to be of the most intimate and cordial nature. While the administrative and supervisory duties made incumbent under the Hatch and Adams Acts are a primary function, the advisory functions growing out of this relationship are an important feature. The whole effort of the office is directed toward encouraging and strengthening the stations and their work. This is sought to be accomplished by conserving their funds to experimental and research work, by protecting their interests in general, and by aiding and stimulating their activities as far as possible along lines of genuine investigation. The publication of the Experiment Station Record contributes to this end through its editorials and its current review of agricultural experimentation and research in this country and abroad.

During the year there was no decrease in the amount of attention directed to the use made of the Federal funds and the work and conditions under them. An annual visitation of all the stations was conducted. This examination of the stations in their respective fields has given first-hand information upon the conditions surrounding them and the classes of local problems presented for their solution. As in previous years, it has afforded opportunity for intimate contact with the personnel as well as the work of the stations, and has enabled personal conferences with the directors and heads of departments and often with members of the local governing boards. In no other way could an adequate and intelligent view be secured of the organization, administration, and work of these institutions, the methods and progress of their work, and the needs in various directions.

During the year new administrative officers assumed their duties at a number of the colleges and stations. In several instances these men had not had previous experience in similar institutions or in executive work of this kind, and hence were not familiar with the aims and methods of station organization and management. This has called for special attention in reference to a wide range of matters in which the proper status and most effective work of the stations would be seriously affected by administrative policy or action.

The growth of the agricultural work as a whole in the State institutions has not been without effect upon the stations, sometimes to their temporary disadvantage. The colleges have very generally had to meet increased demands for both teaching and extension work. Frequently this has been reflected in a larger burden on the station men, since in some institutions the funds have been inadequate to employ additional teachers. The pressure from this increased demand in some cases has tended to dissipate the time and energy of the station workers and distract their attention, while in others it has resulted in drains on the funds set aside for the station, with a tendency to encroach on the Federal appropriations. This has had to be guarded against and in some cases has necessitated disallowances and readjustments. Such cases are confined to a comparatively few States, but their continuance indicates the straitened financial condition of some of the colleges and a failure fully to recognize the station's position. In the absence of increasing appropriations, one of the greatest needs of the stations is that they should receive liberal treatment as departments of the colleges, and should be permitted the full use of their limited funds for purposes which are clearly in the field of experiment and research.

While the plan for developing a practically separate staff of men for station work is making considerable progress, a retrograde movement in this respect has manifested itself in some of the institutions. In these cases not only do important members of the station find less opportunity to concentrate their efforts in that field, but as the staff of the whole institution increases, many of the new members are placed on the station roll for a small part of their time. The staff of the station is thus increased in numbers without a corresponding increase in efficiency or opportunity, and an increased financial and administrative burden is laid upon the station. In its administration of the Federal funds the office has taken the position that experiment station work can not be satisfactorily or economically performed in the fragments of time of men who have heavy college duties and responsibilities. It has therefore closely scrutinized such part-time arrangements from the standpoint of service and apportionment of salary, and has discouraged the practice where an advantage to the station was not apparent. Merely as a convenience or economy in the teaching work of the college, it is held to be without warrant.

The stations have made notable progress in the direction of putting all their work on a project basis. This has followed as a result of their experience with the project system as required by the office for investigations under the Adams fund; and the extension of the system to all station work, regardless of the source of the funds employed, has been systematically urged by the office. It has been found that work planned in the form of definite projects becomes more direct and specific, and results in a minimum waste of time, energy, and funds. The project plan also serves as a basis for the allotment of funds and for administration, and its more general inauguration has greatly facilitated the annual examination by the office.

The research projects conducted under the Adams fund continued to receive careful attention. The supervision of this work by the office extends not only to the outlining of new projects and their approval in advance of beginning work, but also to the progress

of projects already under way and to the manner in which these projects are meeting reasonable expectations as research efforts. In a number of instances it has been necessary to require the transfer of Adams fund projects to other funds because of the inadequacy of the Adams fund as the projects developed, and in other cases advice has been given for strengthening the investigation. In general, however, these projects, as well as those conducted with other funds, are of increasingly high grade and are adding very substantially to the fund of exact scientific and practical information relating to agriculture. In a large measure they are furnishing the basis for improvement through teaching extension.

EXPERIMENT STATION RECORD.

In accordance with the general plan in operation for several years, Volumes XXXIII and XXXIV of Experiment Station Record, each consisting of nine numbers and the usual author and subject indexes, were prepared during the year. These volumes contained about 7,400 abstracts of the world's scientific literature pertaining to agriculture, together with monthly editorials discussing important phases of the development of agricultural investigation and science, and brief notes on the progress of institutions for agricultural education and research in this country and abroad.

The scope of the Record was somewhat broadened by including references to all papers by members of the Department reporting scientific or technical work in outside journals. The range of the Department's work, including as it does extensive regulatory and supervisory functions, is somewhat broader than that of the Record, and papers which do not relate rather definitely to agricultural subjects are being listed by title only. The contributions by members of the Department to scientific and technical journals and similar publications are being listed in each issue and assembled in the index number, where they supplement the list of publications by the Department itself and so convey a more adequate idea of the full scope and importance of its research work.

The scientific literature pertaining to agriculture published in the European countries was abstracted as completely as was possible with the increasing difficulty in obtaining copies of many scientific publications. The domestic literature has continued to increase in both volume and importance, so that congestion of accumulated material is still difficult to avoid under the present space limitations.

INSULAR EXPERIMENT STATIONS.

The work of the several insular stations continued along the lines of agricultural development and diversification previously described. A few changes in the staff of some of the stations permitted the extension of some spheres of activity without abandoning any important lines of work. The permanent equipment of all the stations was added to, thereby increasing their facilities for investigations.

The relations of the stations to the greater portion of the population they are serving continue satisfactory. More requests for information and investigations are received than can be acceded to with the funds now available, but each station is meeting the increased demands to the best of its ability. The need for more extension and

demonstration work is evident, and this is being developed as rapidly as possible.

Active cooperation with various bureaus of this department was continued and is gratefully acknowledged. Without this assistance some features of the stations' activities would have been greatly curtailed.

The appropriations of the several stations for the fiscal year 1916 were: Alaska, \$40,000; Hawaii, \$35,000; Porto Rico, \$30,000; and Guam, \$15,000. The loss of the revenue derived from the sale of products was severely felt by some of the stations. The amounts expended from the still available balances of sales funds during the year were: Alaska, \$1,454.73; Hawaii, \$117.12; Porto Rico, \$1,187.97; and Guam, \$73.67. In Hawaii, \$2,000 was available for the expenses of the Hilo substation and \$12,000 for the marketing division. Both of these sums were appropriated by the Territorial Legislature.

The administrative work in relation to the States Relations Service and the review of the financial affairs of the stations continue as formerly, under the charge of Walter H. Evans and the accounting office of this Service.

ALASKA STATIONS.

The Alaska stations, under the charge of C. C. Georgeson, continued their investigations on the possible agricultural development of that Territory. The spring of 1915 was unusually early and what promised to be a favorable summer changed into a prolonged drought, followed by a very wet autumn. These conditions were unfavorable for crop development. The drought shortened the growth of the grain crops, but the yields of the different cereals were, on the whole, satisfactory. Practically all varieties of wheat, oats, barley, and rye ripened during the season. At the Kodiak station the pasture for the cattle was stunted and the rains coming on later made haymaking and siloing difficult, but enough forage was secured to winter the herd. The spring of 1916 was late, cold, and wet over the whole of Alaska, and the work of seeding and planting was greatly retarded. Late advices from the interior stations indicate the rapid ripening of grain, and it is thought the harvest will be about normal.

The work at Sitka with fruits, vegetables, and ornamentals continue as previously. The hybridizing of strawberries and small fruits was actively pursued, and about 1,500 new hybrid strawberry plants were set out this year. Observations on the more desirable hybrid strawberries in previous years have been continued. A distribution of fruit trees, small fruit bushes, etc., was made to about 225 persons during the year. These will provide an extensive test of the availability of the varieties which has been found most satisfactory at the Sitka station. In addition to extensive variety experiments, a beginning was made to produce distinctively Alaskan varieties of potatoes, several hundred seedlings being given their first test this season. The destruction of cruciferous plants by root maggots was greatly reduced by setting such plants as cabbage, cauliflower, etc., surrounded with small disks of felt or tar paper. This method has been found satisfactory and worthy of wide adoption.

At the Fairbanks station in 1915, more than 1,200 bushels of grain was thrashed, and on account of a serious shortage of seed grain most of this was distributed to farmers in the Tanana and Yukon Valleys under a cooperative agreement to grow the grain, report on its adaptability, and to return to the station an amount equal to the quantity of seed obtained. This will give an opportunity for securing a wide trial, under varied conditions, of some of the varieties which have been developed and tested by the stations. Nearly 200 farmers are enlisted in this experiment. So great success attended the effort to grow turnip seed last year that 200 bushels of selected Petrowski turnips were planted for seed production. About 80 acres were cultivated in grain, hay, and experimental areas during the past year.

At the Rampart station many hybrid barleys, oats, and wheats are now being grown in quantity and this season is expected to give some indication of their relative merits. Winter wheat was considerably injured at this and the Fairbanks stations, but winter rye came through with almost perfect stands. The alfalfas previously reported came through the winter without serious injury. A large number of alfalfa plants are being grown as individuals and their characteristics being observed, and the best will be extensively propagated. About 35 acres are in hay, grains, and miscellaneous experiments at this station. The plant-breeding work of the Rampart station is a very important feature, and it is hoped that the plant-breeding house can soon be completed and equipped. This house is greatly needed to prolong the season during which hybridization work can be continued.

A cooperative experiment was effected with the director of the Tulon agricultural experiment station in Siberia, and a number of exchanges of seed was made. Most of these have been grains that are being tried at the interior stations.

At the Kodiak station the backward season resulted in a longer period of feeding live stock than usual, there being no pasture until the early part of June. The work on the restoration of pastures and meadows was continued, but the drought of 1915 proved detrimental to a considerable degree and resulted in a stunted growth of the plants and a considerable drifting of the ash where exposed to winds. At the close of the fiscal year several head of Holstein cattle were purchased to be added to the station herd. The object of this experiment is to test this breed under Alaskan conditions, and to cross with the Galloway for the production of a dual-purpose animal. There is a demand for hardy, dual-purpose cattle in Alaska, and the results of this experiment are awaited with interest.

The increasing number of settlers in Alaska has made a greater demand upon the stations for seeds and plants. Seeds were sent to more than 2,500 individuals during the year. For many this was the only source of supply, and to others fresher seeds and better varieties were made available.

The necessity of an agricultural experiment station in the Matanuska Valley continues to exist. This region is settling rapidly, and a station should be established along the line of the Government railway, as conditions in this valley are quite unlike those at any of the existing stations. A site for the station has been selected, and its development is waiting upon an appropriation.

HAWAII STATION.

The Hawaii station continued its policy of giving encouragement to minor agricultural industries of the islands in the hope that a more diversified agriculture will be developed. J. M. Westgate, formerly of the Bureau of Plant Industry of this department, continued in charge of the work at this station.

One of the achievements of the station during the past year was the discovery of an efficient means for the control of the yellowing of pineapple plants on soils having a comparatively high content of manganese. The yellowing of the leaves is followed by a poor development of the fruit, which, by reason of its small size and acidity, is worthless for canning. By the simple expedient of spraying the plants several times with a solution of iron sulphate or iron chlorid, the green color is restored to the leaves and the fruit develops in a normal manner. This treatment was tested on a field scale and 20 tons of fruit per acre were secured at a cost of only \$2.50 per acre. Adjacent untreated plats were not considered worth harvesting. If on further trial the preliminary results are confirmed, it is estimated that from 6,000 to 10,000 acres of land can be added to the pineapple-producing area of the islands. In some portions of the islands it has been found difficult if not impossible to sustain the large yields of pineapples, and work is in progress to determine what rotations can be adopted that will prove economically profitable. As a phase of this work, several lines of pineapple breeding have been begun.

In order to maintain fertility of the soil the station has been giving considerable attention to the growing of green manure crops. Experiments with more than 20 species of leguminous plants have been completed, and the chemical features of the experiment have been written up for publication. A number of rapidly growing species were found to be very efficient in maintaining the humus content of the soil, and at the same time restore the nitrogen required by other crops.

The work with forage crops was extended, and increase plats were established for a number of the more promising species. This work is being extended throughout the islands through the collaborators of the stations and cooperating individuals. Considerable interest has been aroused in growing certain selected sorghums for utilization as chicken feed. At present nearly all poultry feed is imported from the mainland, and the local growing of feed is considered important in view of the recent interest manifested in the poultry industry.

In the horticultural department, in addition to the pineapple-breeding work, similar breeding experiments are being carried on with mangoes, avocados, and papayas to develop improved varieties of these tropical fruits. Some investigations were begun with the litchi, a Chinese fruit of remarkable character. Methods of propagation are being sought which will be more certain than the oriental methods of air layering now commonly followed. A very successful experiment in the shipment of litchi seed was carried out between the station and Bureau of Plant Industry of this department. In connection with the study of the litchi a rather serious disease, due to mites, was discovered, for which a satisfactory method of treatment has been found.

Toward the end of the year arrangements were made for the equipment of a plant-disease laboratory, and some much-needed work was begun on certain diseases of potatoes, celery, bananas, taro, and sweet potatoes.

In cooperation with local representatives of the United States Army, forage-production experiments were begun at Schofield Barracks. A tract of 13 acres was set aside for the use of the station, and preliminary experiments were begun with a large number of forage plants from various parts of the world. If this experiment proves a success, a large area of the military reservation will be available for forage production, the importation of hay for Army purposes alone amounting to more than 6,000 tons annually. Since most of the forage of the islands is now imported from the mainland, the success of this experiment will result not only in the production of a supply of forage for the Army, but also in the establishment of a large hay-making industry in Hawaii.

The work of the marketing division, which is supported by territorial funds, under the supervision of the station, continued to grow in amount, and the results achieved are considered important aids to the diversification of agriculture in the islands. The sales during the past year amounted to over \$127,000. In addition to the selling of miscellaneous produce, the division aids in the purchase of feed, fertilizers, seeds, crates, packing material, etc. A new building erected from territorial funds was occupied during the year. In order to dispose of surplus island produce, a branch agency has been opened in San Francisco.

The extension work is being developed along several lines. The diversity of population, language, soil, and climate necessitates visual demonstrations in many localities. Arrangements have been made with representative farmers in the different homestead settlements for demonstration of different crops and agricultural methods, and the results are given wide publicity by the extension workers. Farmers are advised as to the best season for planting their crops for the greatest returns, methods of preparation for marketing, and suggestions given for the cooperative purchase of their necessities. In some instances aid is given in the formation of associations for mutual benefit of the members. Several such associations have been organized. There is a great need for the extension of this service to those individuals who grow small areas of sugar cane for sale to mills. Several thousand acres of cane is grown in this way in tracts of from 2 to 20 acres, but the growers are unorganized and not being affiliated in any way with the Hawaiian Sugar Planters' Association, get no assistance through the experiment station of that association. There are many important problems in connection with the economic production of small areas of cane that need working out, and the growers have come to the station with the request for assistance. The coffee growers and the small growers of pineapple are in a similar position, and an increased appropriation is needed to help them solve some of their difficulties.

PORTO RICO STATION.

The work of the station under D. W. May, agronomist in charge, continued along about the same lines as previously reported. The

loss of the sales funds and no increase in the appropriation made impossible some desirable extensions of the work. A number of projects that have been in progress for several years were completed, and the results are being prepared for publication.

One of the major investigations conducted by the station is the improvement of Porto Rican soils. This problem has been approached from several different points. The use of leguminous plants in restoring the fertility of orchard soils has been investigated, and a bulletin giving some of the results obtained was issued during the year. The station is continuing its investigations with many kinds of leguminous plants, some of which occupy the soil for but a few months, as in the case of cowpeas, or for many years, as with certain tree species. The survey of the guano caves of the islands was continued, and 103 were surveyed, mapped out, and estimates made of the amount of available fertilizer. This work has been supplemented by laboratory analyses and pot tests to determine the availability of the fertilizer constituents. Some studies were begun of the mother liquor from salt works as a possible source of potash, and a survey of the phosphate deposits on Mona Island is contemplated. The availability of the different phosphatic fertilizers for various Porto Rican soils is now being studied. A beginning has been made of a soil survey, combined with a series of field experiments. All these will be extended as rapidly as funds are available.

The technical investigations on the absorption of iron by the rice plant and the selective absorption by plant roots were about concluded. A study was made of colorimetric methods for the estimation of iron in plant ash and the results will soon be ready for publication.

Cooperative experiments with the insular government have been in progress for several years with fiber plants and a number of cordage fiber plants were brought to maturity and given a preliminary test. Before much further work is possible in this line a decorticating machine is necessary to determine the economic value of the different species. Hat weaving is an important minor industry, hats valued at more than \$500,000 having been exported during the past year. The station is contributing to its development by the introduction of the jipi japa palm (*Carludovica palmata*) from which the true Panama hats are made. This plant is being propagated and distributed as rapidly as possible.

In horticulture, the station is paying especial attention to the propagation of the better varieties of mangoes and has begun some shipping and storage experiments with the fruits. The fertilizer experiments with coconuts have been carried on for a sufficient time to show that green manures and commercial fertilizers can be very profitably utilized with this crop. The first crop of station-grown vanilla was sold last summer at \$2.50 per pound. Cuttings of vanilla are being distributed as rapidly as possible and as this plant is adapted to the same conditions as coffee, the production of vanilla should soon develop into an important industry. The work with coffee, in which higher yielding coffees of good quality are obtained by selection or otherwise, continues to be highly successful, and planting of these varieties is becoming quite general over the island. Fertilizer experiments have shown that a light application of readily

available nitrogenous fertilizers when the plants are in flower results in increased yields of marketable coffee.

The plant pathologist is making a study of the diseases of the banana and it is believed that the cause of one of the most destructive has been identified and promising methods for its control have been found. The entomologist has about concluded life history studies of the changa or mole cricket, a most serious pest to many crops. He is also working on cattle ticks to determine if possible a method of eradication applicable to Porto Rican conditions. Cooperative work for the control of coffee insects has been arranged with a number of growers in the worst affected districts.

The work in the improvement of cattle was continued and experiments in butter making in the Tropics under modern sanitary methods were begun.

It has long been felt that the results of the station's investigations were not reaching many who were in need of the information. Many of the people of Porto Rico are remotely situated and know the Spanish language only, and while the publications of the station that are of general interest are issued in that language they do not seem to achieve their full mission. Some demonstration work has been done on a small scale, but it is planned to engage actively in a campaign for the visual instruction of the people.

The station is handicapped in its work with fruits of many kinds by its location. The soil at Mayaguez is a heavy clay and is not adapted to growing citrus fruits, avocados, and many other tropical fruits. A branch station on the northern side of the island where the fruit-raising industry is extensively developed is urgently needed so that the problems of varieties, methods of cultivation, packing, shipping, diseases, insect pests, etc., could be given attention.

GUAM STATION.

The construction work completed during the past fiscal year permitted the proper housing of the live stock and the protection of the tools and implements from the weather. An adequate sewer system has been planned and its construction was begun near the close of the year. The number of visitors to the station was more than three times that of any previous year, indicating a largely increased interest in the work. The station continued to be in charge of A. C. Hartenbower as agronomist.

The work with the live stock was continued along the lines that have been previously described. In December, 1915, 2 Toggenburg buck goats, 2 Berkshire boars, and 14 cockerels, representing the Brown Leghorn, Barred Plymouth Rock, and Rhode Island Red breeds, were added to the breeding stock of the station. These were the first additions to the pure-bred stock of the station since the initial shipment in 1911, a lack of transportation having made it impossible to add to the herds and flocks as soon as was desired. The added stock was received in good condition, although the trip by schooner from San Francisco required 43 days. As a result of the previous shipment numerous grade animals were available for further experiments when the new stock arrived, and work was begun to determine the comparative effects of different amounts of pure blood on development, disease resistance, etc., in the progeny.

Feeding experiments were begun with all the stock to determine the rations necessary under Guam conditions, and preliminary results of these experiments show a favorable result in increased weight of all horses and cattle. During the year an arsenical dip was used to free the station cattle of ticks, and good results are reported from the preliminary experiments. None of the treated cattle showed the high temperatures previously reported. The work with poultry was quite satisfactory during the year, and by better methods of handling the mortality of chicks was greatly reduced and egg production increased. A number of losses were reported among the goats, due to the nodular disease, and all of the goat-breeding stock was sent to the Cotot farm, where it is believed the chances for infestation are somewhat less than at the main station. The sires of the station herds have been placed for breeding purposes with good results at accessible places on the island, and this plan will be extended as far as possible.

The field-crop work was largely concerned with corn improvement, experiments with cotton, rice, tobacco, forage crops, etc. Ear-to-row selection plantings with corn have already developed some valuable strains that far outyield the ordinary Guam variety. The experiments with cotton included ratoon crops and plantings at different times during the year. In 1916 yields of over 1,000 pounds of seed cotton per acre of some Upland varieties were secured from ratoon crops and yields of 1,800 pounds for the first crop of newly planted varieties were obtained. Later plantings did not yield so well. The Egyptian, Sea-Island, and Caravonica cottons did not yield very well during the past year, due partly to late seeding and heavy storms. Cooperative work with cotton has been begun with some of the more progressive natives, with very promising results. The work with rice was only begun this year, and while some very striking results were secured in the fertilizer and variety tests it is too soon to draw any conclusions from them. The forage-plant work included experiments with alfalfa, cowpeas, soy beans, velvet beans, and with Kafir, feterita, and milo, in addition to Para grass, guinea grass, and *Paspalum dilatatum*. The cowpeas, especially when inoculated, and some of the velvet beans gave excellent returns of forage and grain. Kafir and feterita as soiling and grain crops are new to the island, but they have proved valuable, the grain being particularly so for poultry feed, an important consideration in Guam. Planting the stems of Para grass in furrows proved a cheap, rapid, and efficient method of establishing this introduced grass.

The horticultural investigations are largely devoted to testing and distributing tropical fruit trees, ornamentals, and vegetables. Over 31,000 fruit and ornamental trees and a large amount of vegetable and field-crop seed were distributed during the year. The station is cooperating with the Department of Education of the island in the distribution of garden seed, every school in the island now being provided with its garden. The station's plantings have been considerably increased and an experiment in coconut improvement has been begun to develop a better yielding strain that will give a larger percentage of copra than the average now produced in Guam.

The relations between the station and the naval government of Guam have been very cordial, and the cooperative arrangements between them have been carried out with success.

OFFICE OF EXTENSION WORK IN THE SOUTH.

BRADFORD KNAPP, *Chief.*

The Farmers Cooperative Demonstration Work formerly carried on by the Bureau of Plant Industry in 15 Southern States was transferred in the beginning of the year to the States Relations Service, when it was given the official designation of Office of Extension Work in the South.

As now organized this office carries on the following general lines of extension work in cooperation with the State agricultural colleges in the 15 Southern States:

(1) Administrative work in carrying out the provisions of the cooperative agricultural extension act of May 8, 1914.

(2) Demonstration extension work through county agents, which includes the boys' club work.

(3) Girls' clubs and home demonstration work through women county agents.

(4) Extension work of specialists through the county and women agents.

(5) Negro demonstration work, including boys' and girls' clubs for negroes.

ADMINISTRATIVE.

Under the provisions of the extension act all of the extension work of the State agricultural colleges and of the United States Department of Agriculture has been coordinated in the Southern States. There has been established a distinct administrative division of the college of agriculture in each State known generally as the division of extension work or the extension service, in charge of a director, who, under the general plan of administration, is made responsible both to the college of agriculture and the United States Department of Agriculture for the faithful carrying out of the plans mutually agreed to under the provisions of the agricultural extension act.

The basis for this arrangement in each State is a general memorandum of understanding, signed by the president of the college and the Secretary of Agriculture. The project agreements or plans of work are drawn annually by mutual conference between representatives of the department forces and those of the colleges and submitted for approval.

Each of the 15 Southern States composing the extension work in the South accepted the provisions of the act and within the first year adopted plans for the further coordination of all the extension work of the department and the college within the State. Prior to the passage of this act many of the State institutions had little or no funds for extension work, and some of them had never attempted this character of work.

In several of the States the agricultural work of the Department and the State had been coordinated for a year or more prior to the passage of the agricultural extension act.

All the department's cooperative extension work is administered through the Director of the States Relations Service. The southern division of this work is in charge of a chief and an assistant chief,

four field agents as assistants in county agent's work, two men and two women assistants for the home demonstration and club work, and such clerical force as is necessary to properly conduct the correspondence and other office duties.

As provided by the extension act visitations were made at each of the State agricultural colleges to determine whether the provisions of this law were being properly and efficiently carried out, and a report of each examination submitted. In general the provisions of the law were being properly carried out. The few irregularities found were chiefly the result of a lack of a clear understanding of the meaning of some of its features.

A report covering the progress of the work and the results obtained in each of the 15 Southern States has been prepared and submitted to the Director of the States Relations Service to be included in the report to Congress as required by the extension act, also a general report embracing the extension work of the entire 15 Southern States. This general report contained a brief outline of the history of the work, plan of organization in the different States, and the results obtained in the first year's operation.

The director of extension in each State is assisted in the administration by an assistant director or State agent, district agents, and a sufficient clerical force efficiently to handle the office work. The State agent, assisted by the district agents, has supervision of the county agents' work. There is usually an editor whose business it is to look after the publication and distribution of literature for the use of the extension workers. The publications for extension work are prepared by members of the extension or college forces, the subject matter being approved by the heads of division to which it pertains.

COUNTY AGENTS AND BOYS' CLUB WORK.

The general plan of work in the Southern States is to place in every county a well-trained man with practical farm experience as county agricultural agent. He is the joint representative of the Department and of the college of agriculture. It is planned ultimately to place a well-trained experienced woman in every county to have charge of the home economics or home demonstration work for women to correspond with the county agent work for men. Under these two leaders the work of the county is organized. They supervise and assist in conducting a large number of demonstrations on the farms and in the homes throughout the county. The person being instructed agrees to do all of the work and in this way gets the practical lesson to be conveyed. The agents also disseminate a large amount of information by assisting other forces in holding meetings and giving counsel and advice generally when requested by individuals or communities. They assist in the organization of communities into neighborhood clubs for the study of problems relating to the farm, the home, the school, or other questions of community interest. They also organize and conduct the work of boys' and girls' clubs.

Soon after the introduction of the county agent plan of carrying on agricultural extension work, it was found that many farmers could be most easily interested in better methods of corn growing through their sons. This fact, coupled with the desire of the department to educate the boys or future farmers in better methods of agriculture,

led to the organization by the agents of boys' corn clubs and later various other kinds of boys' and girls' clubs. This work with the young people did much to popularize the demonstration work in the South. It early became one of the leading features of the county agents' work.

In all county agent projects at this time the organization and management of boys' clubs is made a part of the regular work of the county agent. The projects for the assistants and specialists in boys' club work all provide that their work shall be carried on in cooperation with and through the county agent.

During the past year 731 regular county agents and 407 women county agents and 26 boys' clubs agents have been employed in the Southern States. There are at present 15 directors, and 15 State agents or assistant State agents in charge of the work of the county agents. There are 447 women engaged in home economics or home demonstration work. Of these 15 are State agents or leaders in charge of the work, 25 assistants and district agents, and 407 county women agents.

Results.—During the season of 1915-16 approximately 110,000 adult farmers carried out definite demonstration work on their own farms under the supervision of agents engaged in the demonstration work. Information, advice, and assistance were given to approximately ten times this number through field meetings, farmers' meetings, circular letters, and in other ways. Each farm demonstration serves as an object lesson for the community in which it is located and influences a considerable number of other farmers.

During the season of 1915 there were demonstrations with farm crops as follows: 446,004 acres in corn demonstrations; 201,974 acres in cotton demonstrations; 2,630 acres in tobacco demonstrations; 196,000 acres in small grain demonstrations; 152,745 acres in hay and forage crop demonstrations; 265,177 acres of cover crop demonstrations; 102,939 acres of summer legume demonstrations; 7,476 acres in potato demonstrations; 105,791 acres of old pastures renovated. Among the many miscellaneous results accomplished during the year 1915 may be mentioned the removal of stumps from 71,819 acres; the drainage of 221,596 acres; and the terracing of 202,705 acres to prevent erosion. There were 29,319 demonstrations in home gardens. The number of improved implements and tools bought at the suggestion of agents, for labor-saving purposes, was 64,079.

Work was done with orchards involving 2,216,000 trees. The agents instructed farmers in the erection of 4,584 silos and 1,579 dipping vats; 29,007 farmers were instructed in the care of manure, with an estimated saving of 3,381,030 tons. Agents instructed 110,570 farmers in the use of commercial fertilizers and advised farmers in 678 cooperative community organizations regarding the purchase of fertilizers, with a saving in cost to these communities of \$125,407.02. They suggested and assisted in the organization of 1,654 community organizations of farmers for the study of local problems and the meeting of local business needs, with a membership of 44,548. The general results of demonstration work have been the widespread adoption of better methods, particularly in the preparation of the land, selection of seed, and cultivation of the crop. The demonstrations, as a rule, exceed the average production by 100 per cent. There has been continued interest in live stock re-

sulting in bringing into the territory, 1,776 pure-bred horses and mares; 8,639 pure-bred and high-grade dairy cattle; 12,560 pure-bred, high-grade beef cattle; 17,739 pure-bred hogs; 9,568 head of pure-bred, high-grade sheep and goats. Demonstrations were conducted with 109,208 head of poultry. The agents secured the treatment of 1,729,177 head of live stock for various animal diseases and pests. Agents made 612,225 visits to farms; they traveled 3,046,577 miles. They were called upon 203,617 times at their office or homes for information; they held 16,010 field meetings and addressed 16,667 meetings, with a total attendance of 1,217,113. They held 5,811 field meetings at demonstrations, with an attendance of 112,668. They distributed 1,283,230 bulletins of the department, the agricultural colleges, and the experiment stations. Four hundred and seventy-three extension schools or short courses were held in their counties, with an attendance of 75,334. There was a total of 62,922 boys enrolled in boys' clubs. In the corn clubs there was an average production of 51.37 bushels per acre, shown by the records of those who reported.

In the other clubs for boys, such as poultry, pig, peanut, etc., equally good showings were made.

WOMEN AND GIRLS' WORK.

The success of the boys' club work led to the organization of clubs for girls in the growing and canning of vegetables and fruits and similar lines of work. Women county agents were employed to organize and supervise the clubs for girls, and after that work had become firmly established the home demonstration work for women was organized and was made a part of the regular work of the woman county agent. The plan of organization of the cooperative agricultural extension work in the 15 Southern States contemplates that each county agent will be at the head of all the extension activities of the United States Department of Agriculture and the State agricultural colleges for men and boys in his county, and the woman county agent will be at the head of all work for women and girls.

Results.—Demonstration work for girls and women began with the canning clubs in 1910, when four counties in two States were organized. In 1915 there were 368 counties with women county agents. They gave direct instruction to 32,613 girls and to 6,871 women. Each of the girls produced a one-tenth acre home garden of tomatoes, or tomatoes and other vegetables. They put up 2,166,515 cans of fruits and vegetables, estimated to be worth \$300,000. The average profit per member was \$24.

Instruction was given in the raising of poultry, marketing of eggs, making of butter, keeping of milk, preparation of food for the table, baking of bread, etc. In the girls' work the women county agents held 10,784 public meetings, attended by 409,283 persons. In the poultry clubs there were enrolled 9,854 members, and 3,062 members in bread clubs. In the work for adult women special attention has been given to labor-saving devices, such as simple home water-works, screening of houses, making of fireless cookers and iceless refrigerators, construction of wheel trays, flytraps, etc. There were 6,871 women demonstrators who did some line of work in their own

homes in the way of home improvements. Two hundred and fifty women's community clubs were organized. In the meetings held for the purpose of instruction there was an attendance of 74,335 women. In a number of counties in Texas, Mississippi, Oklahoma, Virginia, and Louisiana special effort was made to teach farm women to market eggs by organizing egg circles and cooperative egg-selling associations. These were very successful.

The county agents are assisted in their work by a corps of specialists, men and women, who have given special study to particular branches of agriculture or home economics.

SPECIALISTS.

It is not possible for the county agent to be sufficiently well-informed to comply with all the demands that are continually being made upon him for help in the solution of the numerous problems of the farm, the home, and the community. As the work grows and develops the necessity increases for specialists in the various lines of agriculture, home economics, and allied subjects to assist the county agents in handling these difficult scientific problems and also to help in the supervision of special demonstrations with farmers and others for the purpose of giving instruction in these subjects. There are specialists on subjects such as dairying, beef cattle, hogs, poultry, hog cholera, plant diseases, soil improvement, fruits, and vegetables, home canning, curing of meats, marketing, etc. They work directly through the county agents, both men and women, by outlining and helping them supervise practical demonstrations on farms, and assisting in the holding of movable schools of agriculture, farmers' meetings, etc., at various points in their State.

NEGRO WORK.

Demonstration work for negroes is now organized in 11 States, with 51 men and 5 women negro agents. While the white agents have from the beginning assisted the negro farmers and tenants, it was found advisable in some counties where there is a large negro population to appoint a negro agent to work entirely with negroes. Frequently the Federal funds allotted for negro agent work are supplemented by local funds subscribed by the negro population. In some States a negro district agent supervises the work of the local negro agent. There is a close cooperation between the negro agents and the negro schools and other institutions of the State working along the same lines. These agents are instructing and helping thousands of negro landowners and tenants, the plan of work being very similar to that of the white agents. Special stress is placed upon the production of home supplies for the family and stock, and upon the improvement of sanitary and home conditions. Negro children are also receiving instructions, as is partially evidenced by the enrollment of 2,800 members in what are called farm-makers' clubs, the members of which are taught to crop crops, can and preserve fruits and vegetables, and perform other services intended to be helpful to them and to the community. There is no doubt of the beneficial effects of this work among negroes.

SPECIAL CAMPAIGNS.

Special campaigns have been conducted by the extension division, through the county agents, wherever it was deemed advisable, in hog-cholera control, tick eradication, and boll-weevil control work. Specialists from the United States Department of Agriculture and the States assisted in these campaigns.

In cotton territory being invaded by the boll-weevil for the first time the combined efforts of State and Federal agricultural extension workers and the business men are necessary to prepare the cotton growers successfully to meet and overcome the disaster that has always accompanied its advance into new territory. The value of these boll-weevil campaigns is overcoming the fears of the cotton growers and teaching them the proper methods of meeting its ravages, also to restore the confidence of the business interests dependent upon the cotton crop in these localities, can hardly be estimated.

One of the notable special campaigns in which the county agents engaged was that undertaken on account of the fall in price of cotton following the outbreak of the European war in 1914. The southern farmers were caught with the largest cotton crop on record and one that had been made at the greatest expense. For several months cotton could scarcely be sold at all, and then at less than the cost of production, and the depression that followed this sudden collapse in the movement of the South's main cash crop was appalling. For the first time in the history of the country business men, bankers, and in fact those of every profession recognized the full significance of the folly of the one-crop system. For the first time they all worked together and helped put agriculture in the cotton territory on a solid basis; they realized that the money, labor, and resources represented by the cotton crop were tied up in a product that could not be eaten and for it there was no demand in the world's markets.

At this stage a "safe farming" campaign was started, in which everybody took part. The Government forces, cooperating with those of the State agricultural college, being the strongest organization in the field, was used as a nucleus around which to get together for making a united effort to persuade the southern farmers to make provision for feeding themselves and their live stock.

This great cooperative effort to bring about a change was rewarded by making the average southern farm more nearly self-supporting than it had been since the Civil War. The reduction in cotton acreage averaged more than 15 per cent throughout the country. The acreage in small grain, clovers, corn, and forage crops was increased enormously. Interest in the live-stock industry increased more rapidly than it was thought possible in such a short period.

Following the unusual interest aroused by this cooperative movement, the burden of the follow-up work to make this change permanent rested largely upon the activities of the county agents. It is distinctly encouraging to note that the large majority of the farmers throughout the South have adhered to the methods advocated in this campaign, notwithstanding the fact that cotton has since been selling at a high figure. It is estimated that if the food crops grown in the South could be properly distributed they would be almost sufficient to supply the home needs.

OFFICE OF EXTENSION WORK IN THE NORTH AND WEST.

C. B. SMITH, *Chief.*

The extension work formerly carried on by the Bureau of Plant Industry in its Office of Farm Management was transferred at the beginning of the year to the States Relations Service, where its scope was enlarged, and it was given the official designation of Office of Extension Work in the North and West.

As now organized this office carries on five distinct lines of extension work in cooperation with the State agricultural colleges in 33 Northern and Western States, as follows:

(1) Administration work in carrying out the provisions of the cooperative agricultural extension act of May 8, 1914.

(2) Extension work by means of county agricultural agents.

(3) Boys' and girls' club work.

(4) Farm management demonstrations, and

(5) Extension work with farm women by means of women county agents, usually known as home-demonstration agents.

The extension work with farm women was not organized until practically the close of the fiscal year. It is contemplated that this work will supplement the work of the men county agents, having special reference to the farm home and the problems of the country women.

Six women county agents in as many Northern and Western States were at work at the close of the year. The work is too new to report results other than to note the increasing interest in this phase of extension by both men and women. This is shown by the fact that at least 15 counties have perfected their organization and raised funds for cooperation with the State agricultural colleges and the Department in the employment of women county agents for the coming year.

ADMINISTRATION OF THE SMITH-LEVER EXTENSION ACT.

The section of Cooperative Relationships and Projects, with L. A. Clinton in charge, was created in this office to represent the States Relations Service in handling matters in connection with the working out of plans of cooperation between the various bureaus of the department and the States, and to deal with projects for the cooperative work under the agricultural extension act as they are submitted by the States. Specifically, the work of this section has been:

(1) To correlate the extension work of the Department of Agriculture with that of the State colleges of agriculture through project agreements. Project agreements have now been prepared covering practically all extension activities of the various bureaus and these projects have, through the States Relations Service, been submitted to and approved by the State extension directors. Where work along similar lines was being conducted by the States the work of the department and the State has in so far as practicable been harmonized and brought under one system representing jointly the department and the State college.

(2) To cooperate with the State colleges of agriculture in the preparation of plans of extension work in each State as contemplated in the extension act.

From the 33 States 354 plans for work for the year, or projects, were submitted for consideration and approval. In considering these projects particular attention was given to the following points:

(a) Does the work proposed meet the requirements of the act of Congress of May 8, 1914?

(b) Does the object as stated indicate a definite, clear-cut, practical piece of extension work designed to meet the needs of the rural people of the State?

(c) Do the statements under method of procedure indicate a practical, well-considered, clearly stated plan of attack likely to secure results in the accomplishment of the object?

(d) Is the project one which involves funds of any bureau of the Department of Agriculture as well as State extension funds, are the cooperative relationships properly shown, and are the plans for work and the assignment of funds in accordance with the understanding of the bureau concerned?

(e) Does the financial statement provide for expenditures in accord with the subject matter of the project and with the act of Congress of May 8, 1914?

(f) Is the work contemplated under the project of sufficient importance to justify the expenditure of funds as proposed?

(3) To examine extension work in the field to determine its progress and effectiveness and to further its efficiency through conferences and otherwise. This also involves an examination of the financial records of the colleges on the funds received under the extension act.

As all projects for cooperative extension work must be mutually agreed upon by the States and the Department before becoming effective in any State it is necessary that the representatives of the Department have intimate knowledge of the agricultural problems in each State and of the effectiveness of the extension plans being used for their solution. This requires that intimate first-hand knowledge which can only be obtained by personal conferences with the State extension directors and by agreement with them, visitation of the workers, and personal examination of the work in the field. To this end the work in each of the 33 Northern and Western States was examined during the year. As a result of these visitations and field conferences better relationships have been established, and the field workers are coming to feel that they are not only State and county representatives, but also a part of a national system of extension education for the success of which they are each in part responsible. Through these conferences matters of relationships are adjusted, ways are discovered in which the department workers may be of greater assistance to the States, and State administrative officers are apprised of the assistance available in the various bureaus of the Government.

(4) The preparation of the annual report of this Office, which covers in detail the progress of the cooperative agricultural-extension work by projects in each State, and also shows the distribution by projects of all funds entering into the work for the year.

In the performance of the work outlined above a great number of questions arise regarding relationships, approved methods of procedure, action of State legislatures in appropriating money for extension work, the use of funds from various sources within the State as offset to Federal funds, the propriety of certain expenditures of both Federal and State funds, etc.

WORK OF COUNTY AGRICULTURAL AGENTS.

The county agent work of the Office of Extension Work in the North and West was consolidated into a single section January 1, 1916, with W. A. Lloyd in immediate charge. The number of county agents cooperatively employed increased during the year from a total of 330 on June 30, 1915, to 414 on June 30, 1916. Every State has now accepted the plan of extension work by means of paid leaders usually known as county agents, and located permanently in the field, usually in an area the size of a county and paid in part with local funds.

WORK IN RELATION TO CROPS.

The following are a few specific results of county agent work during the past fiscal year based on the reports submitted by the agents on January 1, 1916, and supplementary reports received from county agent leaders since that date. Twenty-one thousand seventy-five farmers were assisted in selecting seed corn. The average increase corn yield per acre on all demonstration fields where results were reported was 12.8 bushels. County agents conducted demonstrations relating to wheat growing on 7,363 farms. The average increase in wheat yield per acre on all demonstration fields where results were reported was 8.4 bushels per acre. Probably the most important line of demonstration work in relation to farm crops was that conducted in connection with seed oats for smut. Twenty-two thousand seven hundred and sixty-two farmers were induced to treat their oats for smut by county agents, involving a total acreage of 708,056. The average increase oat yield per acre on all demonstration fields where results were reported was 11.7 bushels. These demonstrations relating to the elimination of oat smut have now been carried on in some counties for a period of three years and as a result the practice of treating seed oats has become practically universal in these counties. Potato demonstrations were conducted on 3,793 farms. Hay was grown following suggestions of the agents on 3,317 farms. Alfalfa was introduced on 11,311 farms. Particular attention was given to the growing of leguminous crops for green manures. The principal crops used in this connection were sweet clover, soy beans, common red clover, and cowpeas.

WORK IN RELATION TO LIVE STOCK.

During the past year special emphasis was placed on the standardization of breeds within particular communities in an effort to get a majority, at least, of the farmers to keeping the same breed. In carrying out this project, 49 registered stallions, 216 registered bulls, 69 registered rams, and 172 registered boars were secured. Many of these animals were secured by cooperative associations of

farmers. Another especially valuable feature of live-stock improvement has been the transferring from one community to another of sires of worth. Nine hundred and sixty-nine such animals were saved from being sent to the block. One hundred and forty-three cow-testing associations, 90 live-stock breeding associations, and 142 hog-cholera control associations were organized. In those districts where hog cholera was epidemic, the agents were active in promoting control measures. Through the influence of the agent, 204,304 hogs were vaccinated for cholera either by veterinarians or by farmers.

WORK IN RELATION TO FERTILIZERS.

The agents gave instruction in the home mixing of fertilizers on 6,779 farms. Correction of soil acidity was an important problem in many sections. Agents developed 310 local sources of lime and introduced 77 limestone crushers or grinders. These small mills are frequently owned by a cooperative association. A total of 160,618 tons of limestone was used during the year on the suggestion of the agents.

WORK IN RELATION TO FARM BUSINESS.

One of the most important projects undertaken by the county agents during the past year was that relating to farm-management demonstrations or assistance given to the farmer in determining the factors that make for success or failure in his farm enterprises. This project was developed in cooperation with the State farm management demonstration work. Four thousand four hundred and seventy-five farm analysis records were taken by county agents. Four thousand six hundred and nineteen farmers were induced to keep farm accounts, either partial or complete. Another important phase of the work was the promotion of the organization of local farmers' exchanges to facilitate the interchange of products between farmers. The total value of business done through these exchanges amounted to \$341,110. In addition to this the exchanges performed a valuable service in the renting of farms, securing of labor, etc. One hundred and ninety-three farms were rented through these exchanges and 2,935 farmers supplied with farm labor. In many counties the problem of marketing farm products is a most acute one. The agents encouraged and gave assistance in the organization of cooperative marketing and purchasing associations. One hundred and sixty-four such associations were organized by agents during the past year. These organizations did a business of the amount of \$3,575,373, effecting an approximate saving of \$377,975. The most important marketing associations have been in connection with the shipping of live stock. Two such associations, one in Michigan and one in Minnesota, each marketed through its associations in excess of \$500,000 worth of live stock.

WORK IN RELATION TO FARM HOMES.

Many of the county agents have had definite projects relating to the improvement surrounding the farm home. Probably the most important of these is one relating to the installation of water-supply

systems. Three hundred and twenty-one such systems were introduced into the farm homes. Eight hundred and thirty-nine home grounds were planned and sanitary conditions improved in 1,780 cases.

WORK IN RELATION TO YOUNG PEOPLE.

While county agricultural agents do not act as local club leaders, they have been active in introducing this form of extension work into their counties and have directly promoted the organization of 1,503 clubs having a total membership of 37,123.

OUTLOOK OF COUNTY AGENT WORK.

The most important developments during the past year have been as follows:

(1) The tendency has been toward better organized work. The miscellaneous character of advice to individual farmers which was a prominent feature of the work in the first years of its development is being gradually supplanted by definite project work.

(2) Local associations of farmers are assuming a more intimate relation to the work of demonstration. Definite programs for the improvement of the agriculture of the counties are being evolved by committees representing the county association and other organized local groups of farmers. The feeling of local responsibility and cooperation is a most healthy manifestation and is finding expression in strong virile leadership among the farm bureau association members. During the past year farm bureau associations increased their membership to more than 80,000, the average membership in each farm bureau association now being about 300. These associations cooperate with the county agent for the most part through an advisory council and an executive committee.

(3) With more systematic field work has developed more care in keeping and preserving records of work accomplished. Most of the county agents now maintain offices with fairly adequate office facilities. Usually one day each week is spent at headquarters.

(4) More attention is being devoted to a study of local economic facts upon which to develop demonstrations of permanent value. This has been greatly stimulated through the cooperation of the farm management demonstration work.

(5) Extension work in the special interests of farm women has increased and in a number of counties has developed a sentiment for a local specialist in this field.

BOYS' AND GIRLS' CLUB WORK.

This work continued as heretofore in charge of O. H. Benson. Direct financial and other cooperation in the conduct of club work is now maintained in practically all of the Northern and Western States. This work is carried on through the State agricultural colleges and largely in cooperation with the public-school system in each State, the aim being to interest the boys and girls in matters pertaining to the farm and home by bringing them in touch through demonstration work carried on by themselves, with the best known practices in agriculture and home economics.

RESULTS.

During the calendar year ending December 31, 1915, 209,178 boys and girls were enrolled; 127,882 of this number actually undertook work outlined by the leaders; 62,264 completed all work required for the season or year, which was 40 per cent of the total enrollment, and 64 per cent of those who actually undertook work.

Twenty-four thousand two hundred and ninety-nine boys and girls were engaged in profit-making projects, producing \$509,325 worth of food products, or \$20.96 per club member. The total cost from all sources, local, State, and Federal was \$95,000, or a per capita cost of 45 per cent. Basing the per capita cost of the work upon those only who completed their projects, it would be \$1.52.

The State leaders secured 11,478 volunteer local leaders during the year, who assumed leadership of club groups, helped in the local follow-up work, such as holding group meetings, visiting club plats, and keeping up active interest during the entire club period.

The 27 cooperative leaders conducted 1,670 canning demonstrations for the training of club members, with a total attendance of 156,580. They also held 3,829 field meetings, and personally visited 27,733 club plats. They prepared and distributed 2,108,456 pieces of follow-up instruction, the United States Department of Agriculture supplementing this with 1,140,146 circulars.

During the 12 months, 26,534 adults wrote to the Department of Agriculture, requesting that they be furnished the canning instructions used in the boys' and girls' club work. Reports were received from 3,156 of these adults at the close of the season, showing that they had canned 275,836 quarts of fruit and 270,659 quarts of vegetables, or a total of 546,495 quarts during the year, an average per person of over 109 quarts.

In the garden and canning club work 6 members produced over 5,000 pounds of vegetables, 9, 6,000 pounds, 10, 3,000 pounds, and 26, 1,000 pounds.

Important results were also secured in poultry clubs, pig clubs, sewing clubs, sugar-beet clubs, etc.

In order to maintain the interest of club members from year to year and keep them in the work, State champions and those who have made unusual records become members of the National All-Star Achievement Club. Reports from 42 of these champions were received, showing that the average time spent in the work is $2\frac{1}{3}$ years, the longest time for any club member being 6 years.

Boys' and girls' club work is now recognized as a definite extension agency in every northern and western State. More permanent plans for its future development are apparent everywhere. Boys and girls are now enrolling not as a temporary endeavor but with the thought of pursuing the work for a series of years. Club work has been shown to be a most effective way to interest boys and girls in farm life; to establish desirable agricultural practices; to arouse a better community spirit; to increase interest in school work and close the gap between the school and home; to teach thrift and habits of industry; to encourage organized effort and team work; to promote better health among boys and girls.

FARM MANAGEMENT DEMONSTRATIONS.

This work initiated in 1914 for the purpose of teaching the farmer better organization, administration, and business methods, continued under the leadership of L. H. Goddard and has grown steadily in favor with farmers, county agents, and extension directors. The work emphasizes the need in each community of—

(1) A farm business large enough to make possible a fair labor income.

(2) Crop yields as good or better than the average of the community.

(3) Stock which gives returns equal or better than the average of the community.

(4) A farm so organized that it will permit of the maximum use during the year of the work, stock, equipment, and labor on the farm.

These matters are brought home to the farmers through the analyses of the business of groups of farms of about 70 in each group, in which each farmer is shown how to analyze his business with reference to the important factors affecting his labor income and then given opportunity to compare each of these factors on his own farm with the same factors on other like farms in the community as well as with the averages of all farms in the community.

PROGRESS AND RESULTS.

Farm management demonstration work was taken up by five States in cooperation with the Federal Government in September, 1914, the training of men for the duties of State farm management demonstrator beginning the preceding July. At the close of the fiscal year ending June 30, 1916, work was under way in 26 of the 33 Northern and Western States. In 181 areas, 17,985 farm records had been taken, 1,104 meetings held, and 11,481 records returned to the farmers for their consideration. Two thousand and ninety-three farmers are avowedly arranging for readjustments in their farm business as a result of this work and many others will doubtless make such changes. Six thousand two hundred and forty-seven farmers are studying their business more carefully through daily records of receipts and expenses and 3,401 of them have been reached in follow-up work.

The farm management demonstration work in the different areas from Maine to Oregon seem to indicate that each agricultural community where the demonstrations have been made contain approximately 20 per cent of farmers who are making good labor incomes, well above the average of the community, while about 40 per cent are making labor incomes much below the average. The farms of the 20 per cent of better farmers in the community through the analysis of the farm management demonstrator and his tact in calling attention to the factors of success on those farms often serve as a most helpful guide in pointing the way to successful agriculture for the farmers in the community who are not getting along so well.

Farmers who in some cases question the advisability of demonstrations for the purpose of increasing crop yields approve of this farm management demonstration work at once for the reason that its success is measured in terms of dollars per farm instead of yields

per acre or per animal. State extension directors and State leaders of county agents are using the results of this work to show the purpose and value of county agent work when conferring with counties which are considering the installation of a county agent. Teachers of agriculture in the county high schools have been prompt to take hold of farm management demonstration work. They are finding that it fits in admirably with the agricultural work which they have been teaching, and that high-school boys and girls of reasonable maturity who are definitely connected with farms are able to take part in such demonstrations to very good advantage.

OFFICE OF HOME ECONOMICS.

C. F. LANGWORTHY, *Chief.*

During the year the Office of Home Economics carried on investigations on food, clothing, household equipment, and household labor, as well as some cooperative investigations on agricultural subjects with other bureaus in which the respiration calorimeter equipment of the office was particularly useful.

As regards food, the experimental studies of the digestibility and culinary uses of table fats were continued. Investigations on the digestibility of animal fats, as well as of vegetable fats, were completed. A general summary of data on fats and their uses in the home was also prepared for publication as a result of this work. In general, the results obtained have shown that fats are very thoroughly assimilated and that the differences in digestibility of the culinary and table fats having the usual range of melting point are not significant in the consideration of general dietary problems.

The studies of the digestibility and uses in the home of grain sorghums were completed and a report was prepared for publication dealing with the digestibility and uses of milo maize, Kafir corn, feterita, and kaoliang. The general conclusion is that of these grains kaoliang is the least desirable for culinary purposes. The others, from the standpoint of digestibility and flavor, are to be regarded as useful additions to the diet. They are worth using for the sake of economy in regions where they can be grown and in other regions for the sake of variety.

Studies of an emergency ration, carried on at the request of the War Department, were continued with the result that a ration thoroughly tested as to its digestibility, keeping quality, and other requirements, has been recommended to the War Department and by that department ordered manufactured in quantity for Army use. It is believed that the results have justified the exhaustive work which has been done on this problem.

The studies regarding the preparation of food for the table included particularly the use of fruits in combination for canning and jelly making and ways of using fresh and home-canned fruits and vegetables, the household methods of canning meat, and bread making in the home, with special reference to the preparation of a bulletin giving directions for the making of bread of different sorts. Studies of the digestibility of very young veal and of hard palates of cattle, undertaken at the request of the Bureau of Animal Industry, were reported and published.

Much attention was given to revising the earlier popular bulletins on food topics and the preparation of material particularly suited to the needs of the extension offices of this service.

The work on textiles and clothing had to do chiefly with the problem of prolonging wear and the period of usefulness, a matter of manifest economy in household management. As a result of the work on spots and stains and their removal, material has been brought together for a popular and also for a technical bulletin, as well as for two special articles.

Studies were also made with reference to the use of wood in the household. On the basis of experimental and other work, material is being collected for a publication on the general subject of treatment and care of wood from the housekeeper's standpoint to aid the housekeeper in maintaining the quality of wooden utensils, as well as of floors, furniture, trim, etc. In this work the advice of the Forest Service was sought.

The studies of household labor had to do particularly with the time devoted to different household tasks and the ways in which they are carried on, for the purpose of securing data which can be used in connection with the results of determinations made with the respiration calorimeter as to the expenditure of time and energy which different kinds of work demand. Such data are essential to the exact discussion of problems of household labor.

General questions pertaining to the selection of household equipment and its arrangement and use have also been considered.

Cooperating with the Bureau of Animal Industry, respiration calorimeter studies were made of the incubation of hen's eggs, with a view to determining the factors which make for the success in artificial incubation and the possibility of their control. The results obtained have demonstrated clearly the suitability of the method for the study of this problem and, in general, are promising. The same may be said of the results of the respiration calorimeter studies of wintering bees, particularly with reference to economy in feeding, undertaken in cooperation with the Bureau of Entomology. These studies and the work with eggs, it is believed, will yield data of economic importance to the farm woman as well as to the poultry raiser and beekeeper.

During the year special consideration was given to the problem of the preparation of short summaries on home topics and other suitable material for extension work under the extension act and of providing, in cooperation with extension leaders in the different States, the large amount of such material which is demanded in a way which will secure the economical use of resources available for this work.

In addition to the usual reports, summaries, and short articles for popular use, there were prepared for publication during the year 20 documents, about equally divided between popular and technical articles.

REPORT OF THE DIRECTOR OF THE OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING,
Washington, D. C., September 14, 1916.

SIR: I have the honor to submit herewith the report of the Office of Public Roads and Rural Engineering for the fiscal year ended June 30, 1916.

Respectfully,

L. W. PAGE, *Director.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

INTRODUCTORY.

On July 1, 1915, in accordance with the act of Congress making appropriations for the Department of Agriculture for the fiscal year 1916 and effecting reorganization of certain branches of the work, the Office of Public Roads and Rural Engineering formally took over certain rural engineering and architectural work formerly done in other bureaus of the department. The organization and projects under which the work during the past year was carried on are here briefly set forth.

ROAD CONSTRUCTION.

VERNON M. PEIRCE, *Chief.*

The work accomplished in the year under the six general projects is as follows:

EXPERIMENTAL ROADS.

Thirty experimental sections were constructed on the Mount Vernon and the Russell Roads in Alexandria County, Va. The 20 sections on the Mount Vernon Road have a total length of $4\frac{1}{2}$ miles and are as follows: Eight sections of bituminous macadam in which sandstone, gneiss, trap rock, and granite were each used with an asphalt and with a tar binder; 12 sections of bituminous concrete in which sandstone, gneiss, trap rock, and granite were each used with an asphalt and with a tar binder, and bank-run gravel was used with 4 different types of bituminous materials. The 10 sections on the Russell Road have a total length of $1\frac{1}{4}$ miles and are as follows: Seven experimental sections in which various combinations of bituminous materials were used, 2 sections of bituminous macadam in which screened gravel and 2 types of bituminous material were used, and 1 section of surface-treated gravel. A detailed description of these experiments will be found in a special bulletin, "Progress Report of Experiments in Dust Prevention and Road Preservation, 1915" (Department Bulletin 407), issued by this office.

POST ROADS.

Of the 17 post-road projects mentioned in the 1914 annual report as having been selected by the Postmaster General and the Secretary of Agriculture, pursuant to the provisions of the Post Office appropriation act of August 24, 1912, 6, aggregating 181 miles, had been completed at the beginning of the fiscal year. Work was continued on the remaining 11 projects, 8 of which were completed at the close of the fiscal year, as follows: Kentucky—Montgomery and Bath Counties; Maine—Cumberland County; Mississippi—Leflore County; North Carolina—Forsythe, Davie, and Iredell Counties; South Carolina—Aiken County; Tennessee—Loudon and Montgomery Counties; Texas—Bexar, Guadalupe, Hays, Comal, and Travis Counties. The total length of these 8 is 216.6 miles, which, with 181 miles previously completed, yields a total of 397.6 miles. The three unfinished projects aggregate 59.17 miles, so that the total mileage of post roads constructed under the special appropriation will ultimately be 456.77 miles. A detailed report will be made to Congress as soon as all projects are completed.

COUNTY ROAD SYSTEMS.

Studies were made of the existing road systems, the availability of road-building materials, the distribution of population, and the financial and traffic conditions, and recommendations were made for systems of improved roads respectively that would best serve the citizens of the following counties: Lee County, Ala.; St. Francis County, Ark.; Bay and Escambia Counties, Fla.; Spencer County, Ind.; Baltimore County, Md.; Lapeer County, Mich.; Harrison, Holmes, Leflore, Sunflower, Tallahatchie, Tate, Washington, and Yazoo Counties, Miss.; Cass, Clay, Cooper, Johnson, Howard, and Saline Counties, Mo.; Washoe County, Nev.; Hood River County, Oreg.; Perkins County, S. Dak.; Knox and Monroe Counties, Tenn.; Brooks, Hidalgo, and Travis Counties, Tex.; Skamania County, Wash.; Brooke and Greenbrier Counties, W. Va.

SUPERINTENDENCE OF COUNTY ROADS.

A highway engineer was assigned to Monroe County, Ind., to cooperate with the local authorities in the maintenance of some 300 miles of waterbound macadam and the construction of several sections of waterbound and bituminous macadam roads to demonstrate the value of competent centralized control of highway work.

SPECIAL INSPECTION AND ADVICE.

Engineers were assigned to study specific road problems and give advice relative to their solution to the local officials in the following number of communities: Alabama, 3; Arkansas, 3; California, 3; Colorado, 1; Florida, 8; Georgia, 2; Idaho, 2; Indiana, 4; Kansas, 1; Kentucky, 4; Louisiana, 4; Maine, 4; Maryland, 1; Mississippi, 11; Missouri, 2; Nebraska, 3; Nevada, 1; North Carolina, 5; North Dakota, 4; Oklahoma, 4; Oregon, 1; South Carolina, 2; Tennessee, 15; Texas, 12; Virginia, 4; Washington, 2; West Virginia, 7; a total of 113 communities.

In addition to the above special assignments, 3 engineers have been assigned to assist the department of public roads of Kentucky, and 2 to assist the department of highways of Tennessee in their State-aid work. An engineer was assigned to assist the State geologist of Georgia in the examination of the various road-building ma-

terials of that State; at the request of the governor, another was assigned to Texas to assist various localities in that State in the matter of road improvement.

BRIDGE WORK.

Designs for bridges were prepared for the following locations: Florida, 18; Georgia, 1; Indiana, 1; Maine, 1; North Carolina, 8; Virginia, 2; a total of 31. Engineers were assigned to investigate existing and proposed bridges as follows: Indiana, 4; Maine, 1; North Carolina, 3; Virginia, 2; a total of 10; and reports were made on existing and proposed bridges as follows: Kentucky, 6; Maine, 1; North Carolina, 3; Washington, 1; Virginia, 1; a total of 12. Estimates of the cost of proposed projects were prepared as follows: Florida, 1; Kentucky, 6; Minnesota, 2; Virginia, 2; a total of 11. In addition to the above work, general designs and specifications prepared by State highway departments and local officials, and also designs prepared by bridge companies for local communities, were examined and reviewed as an assistance to various local communities.

SQUARE YARDS OF ROADS CONSTRUCTED UNDER OFFICE SUPERVISION.

The following table shows the number of square yards of each type of road constructed during the past 10 fiscal years, 1907 to 1916, inclusive. From this table it is seen that during the past year the engineers of this division have supervised the construction of 4,942,762 square yards of road, or 561.9 miles, assuming all roads surfaced to have been 15 feet in width.

Area, in square yards, of roads constructed during the fiscal years 1907 to 1916, inclusive.

Material.	1907	1908	1909	1910	1911
Brick.....				526	
Concrete.....				1,004	
Oil-cement concrete.....					1,917
Bituminous macadam.....				45,832	41,551
Macadam.....	76,376	72,587	96,107	50,333	11,330
Asphalt-slag.....					578
Oil-asphalt gravel.....					900
Oil-gravel.....				4,819	9,774
Gravel.....	11,722	4,608	65,793	71,376	59,942
Slag.....				4,610	
Sand-clay.....	85,571	42,634	205,032	177,960	218,177
Burnt clay.....		3,392	2,041		
Shell.....		14,020	1,630		
Earth.....	27,042	85,967	319,456	651,109	140,933
Total.....	200,711	223,208	690,059	1,007,569	485,102

Material.	1912	1913	1914	1915	1916
Brick.....		2,055			
Concrete.....		3,013	782	149,333	84,454
Oil-cement concrete.....		1,744			
Bituminous concrete.....		2,898			39,813
Bituminous surfaced concrete.....		4,178			
Bituminous macadam.....	34,453	16,040	10,033	150,131	310,643
Surface treatment.....		6,386	15,911		30,835
Macadam.....	14,806	57,131	168,156	154,742	1,565,963
Gravel macadam.....		2,607			
Gravel.....	13,057	63,730	255,945	548,102	1,848,280
Sand-clay.....	103,876	128,496	86,715	3,568	295,337
Sand-gumbo.....		5,337			
Shell.....		43,717			
Earth.....	556,663	162,696	127,495	273,469	767,437
Top soil.....			26,498	985,984	
Oil-sand.....				1,333	
Total.....	722,855	500,028	691,535	2,266,662	4,942,762

ROAD MAINTENANCE.

E. W. JAMES, *Chief*.

The principal operations of this division were conducted under projects which are mentioned below in detail:

OBJECT-LESSON MAINTENANCE ON THE WASHINGTON-ATLANTA HIGHWAY.

The demonstration maintenance work undertaken on a through route from Washington to Atlanta in the spring of 1914 has been most successfully continued. The total mileage under the supervision of this office increased from 723.7 to 876.3. The cumulative effect of continuous maintenance has been demonstrated by the fact that from March, 1915, to June 30, 1916, the road had not been closed to traffic at any point, even in the winter months.

The same organization has been continued, consisting of 3 engineers assigned continuously to the work, each one being in charge of approximately one-third of the mileage. The total expenditures in the past year on the Washington-Atlanta Highway have amounted to \$120,680.11 for construction and \$26,082.56 for maintenance. This is an increase of approximately \$45,000 over the preceding year. This demonstration work has been attended with such valuable results in the counties concerned that the methods introduced by the office have been followed on other roads.

In Wake County the patrol system has been extended to a large mileage of county road, and in Cumberland, Moore, Richmond, Lexington, and Clarke Counties the work of maintenance is being extended gradually to a considerable mileage of road adjacent to the Washington-Atlanta Highway.

MAINTENANCE OF THE CENTRAL HIGHWAY.

At the request of the State highway commission of North Carolina and in cooperation with that commission and the counties through which the Central Highway passes, arrangements were made to begin demonstration maintenance with the opening of the new fiscal year. Necessary preliminary inspections were made and applications secured from those counties having sections in suitable condition for maintenance. It was found impossible to extend the work westward beyond Catawba River, but all of the counties from Morehead City to the Catawba River have agreed to participate in the arrangement, and have allotted approximately \$14,900 for maintenance on 338 miles of road. The supervision of the Central Highway will require the time of two engineers.

EXPERIMENTAL MAINTENANCE ON SELECTED ROADS.

Maintenance of the experimental roads in Montgomery County, Md., on the Rockville Pike, Bradley Lane, Kensington Road, and the Falls Road, has been continued. Normal increase of traffic has so increased the cost of maintenance on these roads that it was considered advisable to have the county assume some part of the cost of the work. The county commissioners supplied \$800 toward the cost of maintenance and have agreed to increase this amount to \$1,200 for the coming fiscal year.

Traffic census on these roads has been continued according to the French system and exact cost of maintenance has been kept on the 30 experimental sections into which these roads are divided. These data are being collected in their present form for the definite purpose

of establishing the relation between the cost of maintenance and the amount of traffic carried by the road surface. The intent is to develop a set of index figures which will aid in ascertaining the traffic endurance of the various types of surfaces.

The completion of the experimental road on Mount Vernon Avenue, Alexandria County, Va., in the fall of 1915, and the Russell Road in the same county in the spring of 1916, has added 6.3 miles to the experimental roads under maintenance and observation. The same system of records is in use on the 25 experimental sections of these roads.

The post road in Fairfax County is now being surfaced as an experimental road and probably will be ready for maintenance early in the present fiscal year.

Owing to the increased mileage under observation and the growing quantity of work, it has been necessary to assign a superintendent of road construction to the immediate supervision of the repair and maintenance of these roads.

During the past fiscal year, 46,237 square yards of surface have been retreated, and 6,788 square yards resurfaced in addition to the routine patrol work.

MAINTENANCE OF COMPLETED POST ROADS.

Post roads built under the act of August 24, 1912, are being maintained at the expense of the States or local subdivisions. In Maine and Ohio arrangements have been made for cooperative observation, and this office is advising with the State authorities regarding the maintenance of the post roads. A monthly report in which the total cost of maintenance is distributed under various important headings is supplied by the State highway departments. This office assumes the expense of taking traffic observations.

In Maryland the post road has been made an experimental road and its maintenance as such is elsewhere described.

In Virginia the post road in Fairfax County is now being surfaced as an experimental road and will be taken over for maintenance by this office on its completion. The total mileage of the above roads now under maintenance is 55.2.

NATIONAL PARK AND FOREST ROADS.

T. WARREN ALLEN, *Chief.*

An approximate total of 127 miles of reconnaissance surveys and 350 miles of location surveys have been made during the year. Maintenance work has been done on approximately 160 miles. Construction work is in progress on about 170 miles, of which approximately 70 miles were completed during the fiscal year 1916.

The road across the Rabbit Ear Pass in the Routt National Forest in Colorado will open large sections of country hitherto inaccessible, and be available for through traffic. This road is very nearly completed.

The Escalante-Winder Road in the Powell National Forest in Utah, which is in progress of construction, will facilitate communication with a settlement in the valley of the upper Colorado which has heretofore been practically cut off from the rest of the world.

The building of the Trinity River Road, which is now under construction in Trinity County, Cal., will be of great benefit to home-

steads and miners living along the Trinity River and its tributaries. Eventually, it will be a link in a year-round highway connecting the upper Sacramento Valley with the coast of Humboldt Bay.

The survey of Mount Hood Road in Oregon was completed. This road, about 24 miles in length, will permit a comprehensive development of the Oregon National Forest, in addition to providing a southern outlet for Columbia highway traffic.

NATIONAL FOREST ROADS.

No engineer from this office is stationed in district 1 of the Forest Service, but advice in regard to road matters had been given by the chief of the division of national park and forest roads. This district includes Montana and parts of Washington, Idaho, South Dakota, and North Dakota.

In district 2, construction work was done on 8 projects—5 in Colorado, 1 in South Dakota, and 2 in Wyoming. Reconnaissance and location surveys have been made as follows: In Colorado, 13; Minnesota 4 (two for bridge sites); South Dakota, 2; Wyoming, 1. Reports were made on proposed routes from Denver to Mount Evans and on the Pike's Peak Auto Highway in Colorado. Maintenance work was done on 6 projects—4 in Colorado, 1 in South Dakota, and 1 in Wyoming.

In district 3, construction work was done on 2 projects in New Mexico. Reconnaissance and location surveys were made on 9 projects—4 in Arizona and 5 in New Mexico. Some work also was done on the plans for a fifth project in Arizona. Maintenance work was done on 2 projects in Arizona.

In district 4, construction work was done on 9 projects—6 in Utah, 1 in Arizona, 1 in Idaho, and 1 in Nevada. Advice was given in regard to the Yellowstone Park Road in Idaho. Reconnaissance and location surveys were made on 8 projects—5 in Utah, 2 in Idaho, and 1 in Nevada. An examination also was made of a road in the Fish Lake Forest, Utah, which had been destroyed by failure of the reservoir. Maintenance work was done on 14 projects—8 in Utah, 1 in Arizona, 3 in Idaho, and 2 in Nevada.

In district 5, construction was done on 4 roads in California. Reconnaissance and location surveys were made on 6 projects, 1 a bridge site.

In district 6, construction was done on 7 projects—6 in Oregon and 1 in Washington. A small amount of work was under way in Alaska. Reconnaissance and location surveys were made on 3 projects in Oregon and 5 in Washington. Maintenance work was done on 5 projects in Oregon and 3 in Washington.

NATIONAL PARK ROADS.

Very little work has been done in the national parks. The survey of the Lake McDonald-East Shore Line Road in Glacier Park was completed, and a small amount of work done on surveys and plans for the Lake McDonald-West Shore Line Road and the Fish Creek-McGees Meadow Road, in Glacier Park. Plans were completed for the El Portal-Yosemite Road in Yosemite National Park.

The chief of the division made an inspection trip through the Rocky Mountain National Park in Colorado and advised with the superintendent of the park regarding the improvement of the roads.

ROAD ECONOMICS.

J. E. PENNYBACKER, *Chief*.

GENERAL ECONOMIC AND STATISTICAL WORK.

The comprehensive collection of data touching mileage of improved and unimproved roads, taxation, revenues, and bond issues for road purposes, which was begun last year, has been completed. A series of bulletins is now in course of publication.

The collection and compilation of current data relating to the progress of highway work, especially that under the supervision of the various State highway departments, has been continued throughout the year. In connection with this work, a State index is maintained for ready reference, showing progress and other statistics of the several phases of road improvement in each State. Such portions as are of general interest and value are assembled and published annually as circulars.

STUDIES OF STATE HIGHWAY SYSTEMS.

Studies are being made of the organization, methods of operation, and results accomplished by State highway departments, for the purpose of securing a more definite knowledge of the successes as well as failures which have been made by each, in order that the accumulated experience of each of these several departments may be made helpful to all. Studies of one-half of the States having highway departments had been completed at the close of the year.

STUDIES OF COUNTY ROAD MANAGEMENT.

The investigations of road management in selected counties throughout the United States were continued on June 30, 1916. Studies had been completed in 24 States. The ultimate purpose is to issue one or more bulletins explanatory of the systems of road management prevailing in local communities, and indicating the lines along which the best results may be obtained.

STUDIES OF CONVICT LABOR IN ROAD CONSTRUCTION.

The preparation of a comprehensive bulletin on the subject of convict labor in road construction, undertaken in the fiscal year 1915, was completed.

In January an experimental convict camp was established by the county commissioners of Fulton County, Ga. It was conducted by them through the remainder of the year under the observation and in accordance with the suggestions of this office and the United States Public Health Service. The conclusions reached as a result of the extensive study of convict camps the preceding year were thoroughly tested and their success as applied to the camp population of 40 negro convicts under the honor system has demonstrated that in road construction modern methods of penology and sanitation may be applied to convict road camps with distinct gain of efficiency and of economy.

Advice was given to committees of the Legislatures of Georgia and Maryland in connection with convict-labor legislation under consideration by those bodies, and advice in connection with the

operation of individual camps was furnished to the highway departments of Tennessee and Oklahoma.

At the close of the year cooperative arrangements were being made with highway officials in the States of Georgia, Kentucky, New Jersey, and North Carolina for the collection of data relating to the cost of employing convict road labor in those States.

ECONOMIC STUDIES OF POST ROADS.

Studies of the economic effect of the improvement of the 17 post-roads built under the \$500,000 Post Office appropriation act of August 24, 1912, were continued. Final studies have been made on 12 of the roads. The final report, as directed by Congress, should be completed before the close of the calendar year.

TRAFFIC AND ECONOMIC STUDIES.

The traffic studies in the 8 selected counties which have been continued throughout the past 5 years while the roads were being improved under the expenditure of large bond issues were completed. A bulletin covering the results of these investigations will be published.

At the request of the county commissioners in St. Louis County, Mo., which in February, 1916, voted a \$3,000,000 bond issue, an extensive study of the traffic conditions was made in that county in order to assist the local engineers in the selection of the proper road system to be improved and types of surfacing best suited to the traffic requirements. Actual traffic counts were taken for one week at 21 different points.

ADDRESSES, LECTURES, AND PAPERS.

In its advisory work, under this division, the office cooperated with the highway department of Tennessee by the assignment of an engineer to aid in the installation of the necessary system of records and reports incident to the establishment of the new State highway department. Advices and assistance were given in connection with the preparation of bills for the establishment of State highway departments in Florida, Mississippi, and Georgia and with regard to a State bond issue for road improvement in Louisiana. Other advisory work in connection with county organization and management also was given.

During the year 655 lectures and addresses were delivered in 46 States by 64 representatives of the office, as compared with 410 lectures in 1915. The total attendance was 92,610, an average of 142 at each lecture. These lectures were given mostly at farmers' meetings, road conventions, and gatherings of civic and scientific organizations. Seventy-eight papers were read and lectures given in 23 States at colleges and universities and before road schools held at universities and colleges. These road schools were attended largely by local road officials and afforded excellent means of conveying helpful information to such officials.

MODELS AND EXHIBITS.

Exhibits consisting of models and enlarged photographs illustrating the best methods of road, bridge, and culvert construction, road drainage, maintenance, repair, roadside treatment, road building, equipment, machinery, etc., have been made at expositions, congresses, conventions, and fairs.

Exhibits furnished by the office were made at the following places under the auspices of the organizations named:

American Road Builders' Association, Pittsburgh, Pa., February 28 to March 3.

Automobile Show, Fort Wayne, Ind., January 10 to 15.

Chamber of Commerce, Charleston, S. C., March 23 and 24.

Connecticut Agriculture College, Storrs, Conn., January to May.

Copper County Fair, Houghton, Mich., September 28 to October 2.

Fauquier County Farm Association, Marshall, Va., September 29 to 30.

First International Road Congress, Worcester, Mass., December 14 to 17.

Industrial and Mercantile Exposition, Danbury, Conn., November 8 to 13.

International Dry Farming Congress, Denver, Colo., September 27 to October 9.

Lakeland Chamber of Commerce, Lakeland, Fla., March.

Mississippi-Alabama Fair, Meridian, Miss., October 18 to 23.

Mississippi State Fair, Jackson, Miss., October 25 to 30.

Municipal Exhibit, Newark, N. J., November 20.

Ninth Chicago Cement Show, Chicago, Ill., February 12 to 19.

Panama-Pacific Exposition, San Francisco, Cal., to December 16.

Panama Exposition Commission, Panama, Canal Zone.

Road School, Purdue University, Lafayette, Ind., January 25 and 26.

Road School, University of Kansas, Manhattan, Kans., February 28.

Rutland Farm and Horse Show, Rutland, Vt., September 6 to 10.

Second Annual Land Products and Live Stock Exposition, Toledo, Ohio, December 1 to 12.

Seventh Annual Cotton Carnival, Galveston, Tex., July 22 to August 1.

State Fair, Nashville, Tenn., September 20 to 25.

State Fair, Raleigh, N. C., October 18 to 23.

State Good Roads Association, St. Augustine, Fla., March 23 and 24.

State Highway Commission, for use at Kentucky State Fair, Louisville, Ky., September 13 to 17.

State Highway Department, Montgomery, Ala.

Sub-Tropical Mid-Winter Fair, Orlando, Fla., February 15 to 19.

Suwanee Fair Association, Live Oak, Fla., November 2 to 5.

To-day and To-morrow Exposition, Philadelphia, Pa., May 15 to June 10.

Tri-State Fair, Memphis, Tenn., September 26 to October 5.

University of Illinois, Urbana, Ill., January 10 to 21.

Virginia Road Builders' Association, Richmond, Va., January 18 and 19.

Volusia County Fair Association, Deland, Fla., January 25 to 29.

Wisconsin State Fair, Milwaukee, Wis., September 13 to 17.

It is estimated that 680,000 persons examined the exhibits, compared with 440,000 for the year 1915.

GOOD ROADS TRAIN.

A "good roads" train, equipped by this office with a complete set of road models and photographs, and including a lecture car provided with stereopticon and motion-picture equipment, was operated throughout the State of Iowa.

Stops were made at 131 towns and cities and 200 lectures and demonstrations of models were made during these tours. The total attendance at the lectures and demonstrations was 22,000.

PHOTOGRAPHIC WORK AND PREPARATION OF MODELS.

In the photographic laboratory 2,742 negatives, 12,591 prints, 1,738 lantern slides, and 109 bromide enlargements were prepared, and 2,654 new lantern slides were colored. Sixty-four sets of lantern slides were loaned to various individuals and organizations, exclusive of those used in lectures given by employees of the office. There were 16,318 negatives and 10,240 lantern slides on file in the office at the close of the fiscal year.

Eight new models were constructed in addition to the repair and reconstruction work necessary on the models comprising the collection of this office.

ROAD MATERIAL TESTS AND RESEARCH.

PREVOST HUBBARD, *Chief.*

The Division of Road Material Tests and Research was created July 1, 1915, consolidating all laboratory routine and research work of the office under one head. This arrangement permitted material reduction of the clerical force previously assigned to this branch of the work, effected simplification of the files, elimination of unnecessary forms and records, and secured closer cooperation between the various laboratories.

One thousand four hundred and fifty-three samples of road material were analyzed or tested in the laboratories in the fiscal year, an increase of nearly 40 per cent over the preceding year.

ROUTINE CHEMICAL TESTING AND INSPECTION.

Four hundred and seventy-four samples were examined in the chemical laboratory. This is a greater number than for any preceding year and represents an increase of about 13 per cent over the last fiscal year. Of these samples 338 were bituminous materials, 115 metal, and 21 rock, sand, cement, and miscellaneous materials.

PHYSICAL TESTS OF ROAD-BUILDING MATERIALS.

The office continued its policy of testing free of charge for any citizen of the United States samples of rock, slag, gravel, sand, etc., for road-building purposes. The physical laboratory tested 979 samples, an increase of about 55 per cent over the last fiscal year. Of these samples 577 were rock and slag, 160 gravel, 155 sand, clay, soil, etc., 31 cement and concrete, and 56 miscellaneous.

Samples were received from every State in the Union except Wyoming, the more important distribution being as follows: Georgia, 182; Virginia, 155; West Virginia, 57; North Carolina, 50; Indiana, 50; Ohio, 49; Pennsylvania, 45; Maryland, 43; Florida, 42; Tennessee, 38; Texas, 32; South Carolina, 31; Michigan, 27; and New York, 21.

MICROSCOPIC EXAMINATION AND CLASSIFICATION OF ROAD-BUILDING ROCK.

The microscopic laboratory examined and classified 881 samples of road-building material, an increase of about 62 per cent over the last fiscal year. Of these, 574 were rock and slag, 295 gravel, sand, clay, etc., and 14 miscellaneous.

RESEARCH ON DUST PREVENTIVES AND ROAD BINDERS.

A paper upon "The Effects of Exposure on Tar Products" was prepared and will be published at an early date. A laboratory investigation of the suitability of bituminous materials for use in the construction or treatment of earth roads has developed a method of incorporating asphalt with earth without the preheating of the earth. This investigation has resulted in the construction of an experimental asphalt-earth road.

The construction of an experimental refining plant for petroleum and tar products was practically completed. This plant will be used for the purpose of determining what effect variations in refining methods produce on the physical and chemical characteristics of oils and tars.

The following subjects are under investigation: The effect of various solvents upon extracted bitumen; the study of asphalts by means of the penetration test; the relative binding value of various bitumens with different types of rock; bituminous materials suitable for use in the construction of top-soil roads; the thickness of films upon bituminous aggregates; a study of fluid bitumens by means of the viscosity test; a study of heavy refined tars by means of the float test; the effect of colloids on bituminous materials; the effect of oils in oil-cement concrete.

EXPERIMENTAL BITUMINOUS ROAD CONSTRUCTION AND MAINTENANCE.

Supervision or inspection has been conducted in the construction and maintenance of a number of experimental sections of roads in the vicinity of Washington and other places throughout the United States. New lines of experiment include the use of Florida coralline rock with various types of bituminous materials, the use of pit-run gravel in bituminous concrete, the investigation of the comparative value of different types of rock with various bituminous materials in the construction of bituminous macadam and bituminous concrete roads, and the use of screened gravel in penetration macadam. Plans have been completed to investigate the use of bituminous materials. As a result of laboratory investigations an experimental section of natural soil and asphalt road was built at Arlington Farm in co-operation with the Division of Construction.

NONBITUMINOUS ROAD-MATERIAL INVESTIGATIONS.

Investigations were continued on the toughness of cement mortars carrying various percentages of sand and cement, the relation between the physical properties and service results of road-building gravel, and waterproofing silos with oil-cement concrete. The following investigations were started: The effect of freezing and thawing on argillaceous rocks; the relative effect of mortar and sand cushions for brick pavements; and the relation between the tensile strength of mortars and the mechanical analysis of sand.

The following papers and bulletins were also published during the year: "Relation Between the Properties of Hardness and Toughness of Road-Building Rock," in the Journal of Agricultural Research; Department Bulletin 348, "Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials," and "The Section of Rocks According to the Results of Physical Tests as Related to their Use in Different Types of Roads," published as a part of Department Bulletin 370, "Results of Physical Tests of Road-Building Rocks."

STANDARDIZATION OF METHODS OF TESTING BITUMINOUS ROAD MATERIALS.

Department Bulletin 314, "Methods for the Examination of Bituminous Road Materials," was prepared and published; also two papers in the Journal of Agricultural Research: "A New Penetration Needle for Use in Testing Bituminous Materials," and "The Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements." Other investigations have been conducted, having the following purposes in view: The development of a new method for determining paraffin scale; improvements in the fixed carbon determination; the use of ether as a solvent for bituminous materials instead of naphtha; a toughness test for bituminous materials; a standard method of counting ultra-micro-

scopic particles in solutions of bituminous materials. A considerable amount of the work on standardization of methods was done in cooperation with the committee on road materials of the American Society for Testing Materials.

STANDARDIZATION OF METHODS OF TESTING NONBITUMINOUS ROAD MATERIALS.

Department Bulletin 347, "Method for the Determination of the Physical Properties of Road-Building Rock," was published, and a paper on "The Determination of the Specific Gravity of Non-homogeneous Aggregate" was presented before the American Society for Testing Materials. In addition, investigations have been conducted on the standardization of an abrasion test for gravel, a method of determining clay in aggregates, a method of determining the weight per cubic foot of sand, comparison of rational and ordinary sand sieves, method for determining the normal consistency of cement mortars, and the determination of voids in aggregates.

CONCRETE INVESTIGATIONS.

An apparatus for measuring the wear of concrete roads was devised and used in connection with experimental roads constructed under the supervision of the office. Data pointing directly to a more economical design of bridge floors than has heretofore been used have been secured, and the effect of time of mixing on concrete and the strength of concrete with different kinds of aggregates have been investigated.

Two papers entitled "Apparatus for Measuring the Wear of Concrete Roads," and "Tests of Three Large-Sized Reinforced Concrete Slabs Under Concentrated Loading" were prepared and published in the *Journal of Agricultural Research*, while two papers entitled "Tests of Large Reinforced Concrete Slabs," and "The Flow of Concrete Under Sustained Loads" were presented at the annual convention of the American Concrete Institute in January. An article entitled "Oil-Mixed Portland Cement Concrete," which was prepared during the fiscal year 1915, was published this year as Department Bulletin 230.

ROAD AND BRIDGE FOUNDATION TESTS.

An apparatus has been devised and constructed for measuring the distribution of pressure through fills and a paper describing such apparatus was presented before the American Society for Testing Materials under the title "An Apparatus for Determining Soil Pressures." A building especially designed for conducting these tests is under construction at Arlington Farm and plans have been perfected for cooperative field experiments with various public-service bodies.

FARM IRRIGATION INVESTIGATIONS.

SAMUEL FORTIER, *Chief*.

The transfer of this division from the Office of Experiment Stations to the Office of Public Roads and Rural Engineering was effective July 1, 1915. The work was carried on under the following projects:

UTILIZATION OF WATER IN IRRIGATION.

Experiments to determine the best methods of using water have been carried on in cooperation with the following: State of Arizona

in the Salt River Valley; State of California and the California Agricultural Experiment Station in the Imperial and Sacramento Valleys; Colorado Agricultural Experiment Station in the Cache la Poudre Valley; Idaho Agricultural Experiment Station at Gooding, Idaho, and with individuals at Twin Falls, Idaho; Kansas Agricultural Experiment Station at Garden City; Montana Agricultural Experiment Station at Billings; New Mexico Agricultural Experiment Station at State College; State engineer of Nevada and the University of Nevada in Lamoille Valley; Oregon Agricultural Experiment Station at Paisley and Burne; Texas Board of Water Engineers at Mercedes; Utah Agricultural Experiment Station at various points in Utah; State of Wyoming at various points in that State. A bulletin giving the results of such studies in Idaho has been published and a report of the work done in Arizona has been completed. A field laboratory has been established at Denver, Colo., for studies of losses of water by evaporation from water and soil surfaces and the movement of moisture in the soil. Further studies of the movement of moisture in the soil and its relation to irrigation methods under laboratory conditions have been carried on in southern California.

This project also has included the collection of information in humid sections of the United States as to the benefits of irrigation and the methods best adapted to eastern conditions. This work has been done principally in Florida and New Jersey.

PUMPING FOR IRRIGATION.

The work has consisted of mechanical tests of pumps under laboratory conditions carried on in cooperation with the New Mexico Agricultural Experiment Station at that station; mechanical tests of pumping plants in the field carried on principally in Kansas and Nebraska; the collection of data regarding season, cost of maintenance and operation of pumping plants, the amount of water pumped, and the use made of the water pumped at several points in the Great Plains area; and the preparation of a manuscript for a bulletin dealing with recovery of underground water by pumping.

APPLIANCES AND EQUIPMENT FOR IRRIGATION.

Experiments have been carried on to develop improved equipment for irrigation. Models for an automatic measuring device, an improved spray nozzle, and another measuring device have been submitted for public patent, while other appliances are being tested.

FLOW OF WATER IN DITCHES, PIPES, AND OTHER CONDUITS.

The work under this head consists of technical studies to work out formulas for the flow of water in the various types of conduits used to convey water for irrigation. A bulletin on flow of water in open channels has been issued and another on the flow of water in wood-stave pipe has been prepared. Data for a similar report on the flow in concrete pipe was collected.

MEASUREMENT OF WATER FOR IRRIGATION.

The work hereunder consists in laboratory and field experiments to develop devices for measuring water for irrigation. Laboratory experiments were carried on in cooperation with the Colorado Agricultural Experiment Station at Fort Collins, Colo., where a laboratory for this purpose has been built by the station, and in cooperation

with the New Mexico Agricultural Experiment Station at State College. Field experiments have been carried on in cooperation with the University of California at Davis. Bulletins giving the results of experiments have been published by the University of California and the New Mexico station, and results of the work at Fort Collins have been published in the Journal of Agricultural Research. Bulletins based on these results have also been prepared for publication by this department. One promising device developed at Fort Collins laboratory has been submitted for public patent.

CUSTOMS, REGULATIONS, AND LAWS RELATING TO IRRIGATION.

Under this project are carried on studies of the influence of customs, regulations, and laws relating to irrigation on the success of farmers practicing irrigation, on the reclamation of arid lands by irrigation, and on the economical use of public water supplies. Studies of the operation of irrigation districts and mutual and cooperative water companies, the financing of irrigation enterprises, and public control of irrigation have been carried on. A bulletin on irrigation districts in California, prepared in cooperation between the State and this office, has been published by that State, and reports on the other subjects mentioned are in preparation.

DRAINAGE OF IRRIGATED LANDS.

Because of the close relation between irrigation practice and the drainage of irrigated lands and for administrative reasons the work under this project was transferred on March 1, 1916, from the division of drainage to the division of irrigation, except that work under way on that date is being completed by the drainage division.

DRAINAGE INVESTIGATIONS.

S. H. McCrory, *Chief*.

The transfer of the division of drainage investigations from the Office of Experiment Stations to the Office of Public Roads and Rural Engineering was effective July 1, 1915. To centralize the work local offices in the various States, except those maintained under cooperative agreement with State experiment stations and agricultural colleges, were discontinued. The project relating to irrigated lands was transferred to the division of irrigation, so that the work of this division is now devoted exclusively to the humid and semihumid sections.

The drainage division has done more research work and devoted more attention to the requirements of the individual farmer in the way of farm drainage.

The principal projects for which surveys, plans, and estimates were completed are as follows:

Overflowed lands.—Mayfield Creek, Ky., 25,000 acres; Panther Creek, Ky., 42,000 acres; Luxapallila River, Ala., 22,000 acres; Monona-Harrison drainage district, Iowa, 70,000 acres.

Swamp lands.—Buckfield Lodge, S. C., 1,500 acres; Combahee Corporation tract, South Carolina, 2,000 acres.

Irrigated lands.—Palisade drainage district, Colorado, 630 acres; French prairie district, Oregon, 15,000 acres; Hershey drainage district, Nebraska, 41,000 acres.

Surveys, plans, and estimates were made for farm drainage systems on 98 separate tracts in the humid section and 28 tracts in the irrigated region.

Forty-two preliminary examinations were made of proposed drainage districts, and recommendations made for further procedure.

Along the line of research work the collection of data on run-off and the cost of operation of pumping plants in southern Louisiana was continued. The subjects of the drainage of muck soils and of the shrinkage of muck soils after draining were investigated. Studies were made of the run-off from agricultural land, principally in Tennessee, Louisiana, Missouri, Iowa, and Idaho. The hydraulic plant at the Arlington Farm, Virginia, was completed and experiments begun for the determination of coefficients of flow in clay and cement drain tile. Considerable time was devoted to a study of the question of organization and financing of drainage districts. Progress was made in the compiling, by States, statistics of the swamps and overflowed areas of the United States.

RURAL ENGINEERING.

E. B. McCORMICK, *Chief.*

This division was officially organized July 1, 1915, and the work during the fiscal year has been conducted under the three following classifications:

FARM DOMESTIC WATER SUPPLY AND SEWAGE DISPOSAL.

Requests for detailed information regarding the pumping, storing, and distributing of water, the development and protection of sources of water supply, and the installation of sanitary methods of sewage and garbage disposal have been numerous and have received close attention.

Plans for water-supply systems of the following types have been prepared:

Springs with a hydraulic ram pumping water to an elevated underground concrete reservoir, with distribution piping to house and barns.

Flowing well with a hydraulic ram pumping water to a reinforced concrete standpipe, from which the overflow passes through a cooling tank and chamber.

Plans for sanitary utilities and for sewage disposal plants of the following types have been prepared:

Sanitary privies and closets, including plumbing systems and cesspools.

Septic tank with subsurface distribution of the effluent for both level land and hillside conditions.

Septic tank and treatment of effluent in a sprinkling filter.

When desirable from the viewpoint of subsequent operation of the plant and the further dissemination of information, the work has included the supervision of the construction, as well as the preparation of the plans.

Surveys have been made and the grades of sewers established and staked for the animal husbandry farm of the Bureau of Animal Industry at Beltsville, Md.

CONSTRUCTION OF FARM BUILDINGS.

Designs have been prepared for the following structures, blueprints of which are supplied upon request:

Southern farmhouse, prepared as the result of investigations in the South regarding the present housing conditions in the rural districts. One thousand copies of these plans have been sent upon request to prospective builders.

Farmstead layout, prepared as the result of investigations in the field.

Hay shed, open-center construction and trussed frame, which leaves center free of braces.

Corn crib of 2,000 bushels capacity; the principal features are thorough ventilation, rat-proofing, and substantial construction.

Three farmhouses, suited to Northern conditions.
 General barn, suited to conditions prevailing in the North Atlantic States.
 Horse barn of general application.
 Combined machinery and wagon shed and shops.

A study has been made and data collected relating to the hog-raising industry and equipment necessary thereto on the various reclamation projects in the West; preliminary drawings for several types of buildings have been prepared.

RURAL ENGINEERING PROBLEMS INVOLVING MECHANICAL PRINCIPLES.

Numerous requests for information and advice relating to the following subjects have received attention, in many cases requiring considerable research:

- Electric lighting plants for farms,
- Ice and refrigerator houses for farms,
- Refrigeration systems,
- Residential heating plants.
- The generation of power on the farm.
- The use and operation of windmills.
- Operation and internal-combustion engines—gas and oil.
- Application of various fuels for internal-combustion engines,
- Concrete design and waterproofing.
- Electric cooking, lighting, and heating.
- Farm machinery.
- Hydroelectric power plants for farms.
- Windmill electric plants for farms.

Investigations of thrasher explosions have been conducted in co-operation with the Bureau of Chemistry throughout the wheat-growing districts of the Northwest, with a view to determining the exact causes of such fires and the means for overcoming the trouble. As the result an automatic fire extinguisher for thrashing machines has been designed and has proven very effective. In response to requests, about 300 sets of plans of this extinguisher have been sent to owners and operators of thrashing outfits.

A device has been prepared for determining the draw-bar horsepower of tractors.

TRACTION TESTS.

The object of the traction tests which have been continued throughout the year is to determine the actual effect of road improvement on draft and also the effect of width of tire.

The dynamometer that was wrecked in a collision with a locomotive has been rebuilt with slight improvements in design and refinements in construction. Preliminary and final tests have been run on the post roads in Virginia, South Carolina, Maine, Maryland, Texas, Iowa, Alabama, Mississippi, and Ohio. These projects range from 5 to 75 miles in length. The reports for all of these projects are either completed or in process of compilation. Two final tests are yet to be made, one in North Carolina and one in Iowa.

Several tests have been conducted with the torsion dynamometer designed in the office and attached to the propeller shaft of a 6-cylinder automobile.

A complete set of drawings of the redesigned dynamometer have been prepared, and have been furnished on request to several manufacturers of tractive machinery and trailers who are contemplating the construction of such apparatus for testing their products.

REPORT OF THE SOLICITOR.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SOLICITOR,
Washington, D. C., September 15, 1916.

SIR: I submit herewith the report of the work of the Office of the Solicitor for the fiscal year ended June 30, 1916.

Respectfully,

FRANCIS G. CAFFEY, *Solicitor.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

SUMMARY.

There were two notable features of the activities of the office for the fiscal year 1916: (1) The large amount of assistance rendered in drafting, or reporting on, proposed legislation; (2) the improvement of methods, resulting in saving to the Government and in the accomplishment of a greater quantity of work without increase in expense or of employees.

Under your direction, on the request of committees or Members of Congress or of State officials, more than 40 bills relating to agricultural matters have been drawn or examined and commented on.

Four of the bills resulted in comprehensive statutes, enacted by Congress at the last session, dealing with aid in the construction of rural post roads, cotton futures, grain standards, and warehouses, and two, in brief statutory provisions of importance, dealing with the protection of game on lands acquired under the Weeks forestry law and the development of mineral resources on those lands. The Federal aid road act was approved July 11, 1916 (Public No. 156). The other measures were incorporated in the agricultural appropriation act for the fiscal year 1917, approved August 11, 1916 (Public No. 190).

Other bills, for the consideration of Congress, in the preparation of which aid was given, covered the regulation of interstate and foreign commerce in viruses, serums, toxins, and analogous products for the treatment of domestic animals; amendment of the 28-hour law; rural credits; admission of tick-infested cattle into the United States; acceptance of lands by the United States for game and bird preserves; amendment of the Alaska game law; redistribution of jurisdiction over fur-bearing animals in Alaska between the Departments of Agriculture and Commerce; development of waterways and water resources and the control of floods; designation and withdrawal of water-power sites and the construction of water-power plants for the manufacture of nitrates; creation of a commission to ascertain the practicability and best means of producing nitrogen compounds

by fixation of atmospheric nitrogen and procuring potash from kelp, alunite, and feldspar, or any other material, for use in the manufacture of munitions of war and fertilizer; and the labeling of imported hops.

The office took part in drawing, for the consideration of State legislatures, two bills providing for the organization of cooperative associations and one to regulate the marketing of agricultural products.

In addition, assistance was rendered in making up the reports of the department on numerous subjects of pending Federal legislation. Frequently these embraced elaborate, detailed suggestions of amendments. The bills, among other things, covered the grading of grain; inspection and marketing of melons; establishing a standard box for apples; revising the public printing laws; simplification of the method of condemning lands by the Government; amending the national bank act to provide for extension of credit to farmers; establishing the Landschaft system of farm mortgages and credits; admission of tick-infested cattle into the United States; establishing game sanctuaries in the National Forests; Federal aid in the construction of public roads in the States; development of waterways and water resources and the control of floods; requiring manufacturers, producers, canners, and packers to place their names and addresses on labels of packages of foods; control of the administration of drugs used by inhalation; branding of imported hops; manufacture, sale, and shipment of alcoholic liquors; interstate commerce in milk and milk products; administration of oaths in certain cases by agents and employees of the Department of Agriculture; standards of maturity for oranges; and repeal of the mixed-flour law.

At the instance of the governors of California and Washington, suggestions were made relative to legislation for the conservation and utilization of kelp beds on the Pacific coast and for the promotion and protection of the manufacture of potash from kelp. Comments and suggestions were made on a proposed bill in South Carolina regulating warehousing; on marketing bills in Massachusetts, California, and Virginia; and on a bill authorizing the formation of cooperative associations in Mississippi.

Aid was given in revising a convention between Great Britain and the United States for the protection of migratory birds in Canada and the United States. This was signed August 16, and ratified by the Senate August 29, 1916.

On August 5, 1915, you joined the Secretary of the Interior in making an order providing for the conduct by this office of all hearings in cases of Government contests arising out of claims to lands within the National Forests. Previously, agents of the General Land Office were in charge of the hearings, this department merely rendering assistance. Now this office is in exclusive charge of the hearings, and the General Land Office is relieved of the expense and time required by attendance. The new scheme is an economy and has proved satisfactory.

Notwithstanding a decrease in the force of title attorneys, a greater quantity of title-examination work under the Weeks law was accomplished than during any preceding year. This result is attributable in part to the title attorneys becoming more skillful as

time goes on, but also in part to the employment of a better system of handling.

Much attention has been given to reducing the time between the commission of offenses and the transmission to the Department of Justice of cases under the regulatory laws. Under several of the laws the reductions already effected have been substantial. With a view to increasing efficiency in the plans of collecting evidence of the commission of offenses and of preparing the papers to be sent to the Attorney General, a conference was held from February 28 to March 2, 1916, between representatives of this office and of all the bureaus of this department charged with the administration of these laws. A stenographic report of the proceedings has been submitted to you.

The practice of reporting cases to the Attorney General in the form of proposed informations, already drafted for use by the United States attorneys, instead of by mere letters reciting the facts, was instituted during the fiscal year 1914 in food and drugs cases. It proved so satisfactory that it has now been extended to prosecutions under various other laws, with which this department is concerned, where it is possible to proceed by information. The new method has saved much time to the officials both of this department and of the Department of Justice, has avoided a great deal of wasted double effort which formerly occurred, and has facilitated the speedy disposition of litigation. If the bill, pending in Congress during the past two sessions, to confer authority on officers of this department to administer oaths were enacted, a still greater saving of both time and money would be effected, and the periods between the commission of offenses and the termination of prosecutions could be much further reduced.

The ordinary activities of the office, while in the aggregate greater than in the preceding year, in some respects diminished and in others increased.

For the Forest Service there were fewer claims and trespass cases and more general litigation, formal opinions, and contracts. Under the Weeks forestry law more purchase agreements were prepared, more reports on titles completed, and a greater number of tracts, as well as a greater acreage, of land acquired. In 1916 223 more written opinions were rendered, 220 more contracts, leases, bonds, and instruments of like nature prepared, 13 more applications for letters patent on inventions of department employees filed, and 36 more claims for balances due estates of deceased employees of the department handled, than in the previous fiscal year. In 1916 there were increases over 1915 in the number of cases transmitted to the Department of Justice of 489 under the food and drugs act, 82 under the meat inspection act, 36 under the insecticide act, 26 under the virus act, and 21 under the Lacey Act; and decreases of 81 under the laws for the protection of the National Forests, 117 under the twenty-eight hour law, 121 under the animal quarantine acts, and 38 under the migratory bird act. Differences in numbers of violations reported under the other regulatory laws were slight. There was a net increase of 277 in the total violations reported under all the laws.

The most marked increases in the various types of work of the office were in nonlitigated matters.

Law work for the Forest Service during the year, other than under the Weeks forestry law, included handling the following cases and other business:

Claims to lands.....	590	Trespasses—Continued.	
Hearings attended.....	56	Fire.....	37
Depositions taken.....	64	Occupancy.....	40
Briefs prepared and filed..	52	General litigation.....	39
Oral arguments.....	11	Written opinions.....	741
Trespasses:		Contracts.....	1,967
Grazing.....	117	Proclamations.....	2
Timber.....	67		

The following summary shows what the office did in the fiscal year 1916 in connection with the acquisition of lands under the Weeks forestry law:

Character of work.	Tracts.	Acreage.
Purchase authorized by the National Forest Reservation Commission.....	65	54,898.00
Agreements of purchase prepared.....	153	150,321.00
Titles in process of examination at the beginning of the year.....	49	263,761.00
Examinations of titles completed and reported to the Department of Justice:		
Purchases recommended.....	112	170,981.33
Condemnations recommended.....	171	143,247.67
Examinations of titles completed but not reported to the Department of Justice.....	55	66,702.52
Titles in process of examination at the end of the year.....	40	150,873.07
Completion of direct purchases after approval of titles by the Attorney General.....	112	254,948.81
Completion of purchases of lands acquired through condemnation.....	56	103,733.77

Two meetings of the National Forest Reservation Commission were attended.

In addition to the 1,967 contracts prepared for the Forest Service and the 153 purchase agreements under the Weeks law, 135 contracts, 217 leases, 63 bonds, 315 renewals, and 40 notices of termination were prepared for the several bureaus, divisions, and offices of the department, making a total of 2,890 documents of these classes.

One thousand three hundred and eighty-two written opinions, including 741 for the Forest Service, were rendered. No account was kept of the numerous informal opinions.

Twenty applications for letters patent on inventions of employees of the department for dedication to the public were prepared and filed.

Fifty-six claims for balances due estates of employees of the department who died intestate were examined, the necessary papers prepared for their payment, and advice furnished administrative officers of the department relating to the same.

Eighteen cases involving questions of irregularity or misconduct by employees in their official duties were reviewed. In each the facts were investigated. In nine formal charges were prepared; after the employees concerned had had full opportunity to reply, the charges, the answers, and the evidence received consideration, and the matters were reported to you for decision. In addition, nine memoranda were prepared on general questions relating to the personnel of the department.

Several conferences were held with representatives of the Bureau of Plant Industry and importers with reference to formulating a plan for carrying out the agreement with Germany to allow sugar-

beet seed to be exported for use exclusively in the United States. This department consented that the seed might be shipped to it for distribution. As a safeguard against violation of the terms on which the articles were brought into this country it was decided to require the importers to file with the department bonds in a penal sum equal to the value of the seed, conditioned in accordance with the agreement with Germany. The office prepared a draft of the bond and subsequently examined and passed upon the sufficiency of execution of 46 such bonds.

At the request of the Office of Markets and Rural Organization, representatives from this office attended conferences in the Pacific and Northwestern States with persons interested in the formation of cooperative organizations for marketing farm products. Similarly, representatives of this office visited points in New York, Ohio, Tennessee, Georgia, Alabama, and Louisiana to obtain information affecting the handling, storing, and marketing of staple agricultural commodities through warehouses.

Aid was given the Advisory Committee on Finance and Business Methods in drafting regulations governing the methods of receiving, recording, caring for, issuing, disposing of, and accounting for Government property, and in amending the administrative and fiscal regulations; to the Office of Markets and Rural Organization in drafting orders and notices establishing and promulgating standards of color for cotton, and in drafting for the Rotterdam Cotton Association rules governing spot transactions and future trading in cotton; to the Bureau of Animal Industry in drafting regulations governing the interstate movement and importation of live stock and hides of animals under the animal quarantine laws, and for administration of the virus act; to the Biological Survey in drafting regulations for administration of Federal bird reserves; to the Forest Service in drafting regulations and instructions for the administration of the National Forests; also to the administrative officers of the department generally in revising and preparing proposed amendments to sundry other regulations.

Many documents of various kinds, including statements of issues, briefs, and memoranda on legal matters, were prepared on behalf of the officials of this department for submission to the Attorney General, the Secretary of the Interior, the Comptroller of the Treasury, and officials of other departments. Among the questions were whether the act of March 4, 1911 (36 Stat., 1236), which permits the admission of tick-infested cattle from Mexico into that part of Texas below the southern cattle quarantine line, is constitutional; whether withdrawals of public lands as proposed additions to National Forests in Wyoming and Colorado may be made in aid of pending legislation; whether the Department of Agriculture has jurisdiction over lands in the National Forests withdrawn for reclamation purposes, but not in actual use by the Reclamation Service in the development of a reclamation project; whether a foreign corporation may be permitted to utilize lands in the National Forests for the development of hydroelectric power; whether a right of way for the construction of a road over patented lands within the boundaries of a National Forest can be purchased out of the Forest Service appropriations for improvement of the National Forests.

There has been continued growth of the practice, mentioned in the last annual report of this office, of informal conferences with the administrative officials of the department respecting legal questions arising in their work and of examinations of letters and of manuscripts for publication prepared in other subdivisions of the department.

A conference was held at Denver with all the district assistants to the Solicitor for the purpose of discussing problems arising in the legal work of the department, especially as it affects the administration of the National Forests.

Violations of statutes intrusted to the department for enforcement upon which reports were made and prosecutions recommended to the Attorney General, or upon which settlements were effected without litigation, and the amounts of fines and recoveries in cases terminated and reported to this office during the year were as follows:

Law invoked.	Violations.	Fines and recoveries.	Law invoked.	Violations.	Fines and recoveries.
Laws for the protection of National Forests.....	300	\$29,579.02	Lacey Act.....	51	\$906.00
Food and drugs act.....	1,364	15,905.56	Insecticide act.....	87	2,040.00
Twenty-eight hour law.....	465	52,450.00	Virus act.....	38	185.00
Animal quarantine acts.....	68	11,680.00	Miscellaneous.....	13	435.00
Meat inspection law.....	237	3,250.00	Total.....	2,623	116,430.58

\$2,208.04 outstanding.

In addition, 543 decrees of condemnation and forfeiture were entered under the food and drugs act and 10 under the insecticide act.

This office examined all the evidence gathered by department inspectors and communicated to it under these several regulatory statutes, and advised that prosecutions could not be maintained in a considerable number of cases.

Reports coming to the office from various sources which disclosed apparent violations of the postal laws and regulations, as heretofore, were referred to the Postmaster General for investigation.

Many memoranda on legal questions were furnished on cases reported to the Department of Justice for prosecution, and, in some, assistance was given in the trials. Among the important cases in which this office assisted in the preparation of briefs were *Cameron v. Weed* and *Birdno* (226 Fed., 44); *United States v. Utah Power & Light Co.* (230 Fed., 328); *United States v. Utah Light & Traction Co.* (230 Fed., 343); *United States v. 40 Barrels and 20 Kegs of Coca Cola* (241 U. S., 265); *Hubbard, et al., v. Lowe* (226 Fed., 135); *Weld, et al., v. Lowe* (unreported); *United States v. Great Northern Railway Co.*, still pending; *United States v. Colorado Power Co.*, still pending; *United States v. Cameron, et al.* (2 cases), still pending; *United States v. John Miolin, et al.* (unreported); *United States v. Hohennadel* (F. and D. No. 7243); *United States v. 25 Bags of Nuts* (F. and D. No. 5462, Notice of Judgment No. 4329); *United States v. 7 Cases Buffalo Lithia Water* (44 D. C. App., 162); *United States v. 11 Gross Packages Dr. Williams Pink Pills* (F. and D. No. 6384); *United States v. Parke, Davis & Co.* (I. and F. No. 140); *St. Louis Independent Packing Co. v. David F. Houston, et al.*

(231 Fed., 779) ; and Pittsburgh Melting Co. *v.* B. & O. R. R. Co. and Totten (232 Fed., 694).

Tabulated statements showing, in detail, the facts and status of the principal prosecutions originating in the department, in which United States attorneys have commenced proceedings, and of the claims and other cases affecting the administration of the National Forests in which this office is concerned, are submitted for your information. It is recommended that these be filed for reference.

No law clerks were added, and there was a decrease of three in the number of title attorneys during the year. The work was current at the end of the year.

Somewhat detailed statements of the principal activities of the office, without reiteration of what has been fairly covered by the foregoing summary, follow.

ADMINISTRATION OF ACTS OF CONGRESS.

STATUTES RELATING TO THE NATIONAL FORESTS.

LAND CLAIMS.

Five hundred and ninety cases, involving about 220,000 acres of land claimed under the homestead, timber and stone, mineral, lieu and railroad selection, and other general and special land laws of the United States, were handled.

Two hundred and eighty decisions were rendered, including those of registers and receivers and the Commissioner of the General Land Office, subject, respectively, to review by the Commissioner and the Secretary of the Interior. The registers and receivers decided 30 cases for and 30 against the Government. The Commissioner decided 119 cases for and 47 against the Government. The Secretary decided 33 cases for and 21 against the Government. Of the 280 cases, 198 were closed during the year, 130 by decisions for and 49 against the Government, 8 by relinquishments filed by the claimants, 7 by voluntary withdrawal of Forest Service protests, one by withdrawal of final proof after protest by the Forest Service, 2 by elimination from the Forests, and one by cancellation for failure to make proof within the statutory period. As a result of the 130 decisions for the Government, approximately 108,409 acres of land, supporting a stand of more than 240,000,000 feet of timber, valued at more than \$400,000, were retained in the National Forests.

The remaining 310 cases received attention varying in degree with their progress in the Forest Service and in the Department of the Interior.

Hearings were attended in 56 cases. Oral arguments were made before the Secretary of the Interior in 11 cases. Depositions were taken in 64 cases. Briefs were filed in 52 cases. In 7 cases motions for rehearings, and in 4 petitions for supervisory authority, were filed, together with supporting briefs. Appeals to the Secretary of the Interior, supported by briefs in 6 cases, were prosecuted from adverse decisions of the Commissioner.

The assistants to the Solicitor in the field examined and passed upon the evidence in many cases, preparatory to reports to the Commissioner of the General Land Office recommending adverse pro-

ceedings. They were also in frequent conferences with executive officers of the Forest Service on questions arising out of claims cases.

DECISIONS OF THE DEPARTMENT OF THE INTERIOR.

A decision of the Secretary of the Interior of August 31, 1915 (Instructions, 44 L. D., 359), holds that lands of the United States upon which this department under authority of its appropriation act has constructed a telephone line or like structure are thus devoted to a public use pursuant to a law of Congress. Therefore a subsequent patent to the land will not, unless expressly so provided, convey to the patentee the title to such structure, or the right to operate and maintain the same. Hence an exception thereof and of the rights and incidents necessary thereto may lawfully be made in any subsequent final certificate and patent issued for the legal subdivision on which the structure is located.

A decision of January 13, 1916 (Instructions, 44 L. D., 513), recognizing the application of this principle to roads, trails, and other improvements, holds that to warrant the insertion of an exception in the final certificate or patent, it is necessary that a sufficient fund for construction be set aside and that some action, such as staking the area to be retained by the United States, be taken indicating on the ground that the tract has been devoted to a public use. A preliminary survey is not sufficient for this purpose.

In Robert L. Morris (44 L. D., 439), it was held that a settler on land included within a National Forest who at the date of the withdrawal was not qualified to make homestead settlement, being the proprietor of more than 160 acres of land, had no right which would except the land from the withdrawal. Hence his subsequently reducing his holdings could not operate to give him such right.

TRESPASS.

Damages and fines recovered during the year for trespasses upon the National Forests were:

Class of trespass.	Damages.	Fines.
Grazing.....	\$7,366.52	\$225.00
Timber.....	17,839.89	.....
Fire.....	1,594.99	65.00
General.....	2,352.61	135.01
Total.....	29,154.01	425.01

In addition, 40 cases of illegal occupancy of National Forest lands were handled during the year, involving principally the unauthorized use of lands for hydroelectric power development and transmission, illegal inclosures, and claims of title adverse to the United States. They were dealt with mainly by the institution of injunction proceedings or settlement without recourse to the courts. Decrees for the United States were entered in 5 cases and temporary injunctions issued in 3, which are still pending. Six cases are pending on appeal, 3 were settled without the necessity of legal proceedings in the courts, and the remainder were pending in various stages at the close of the year.

GENERAL LITIGATION.

Thirty-three cases not referable to any of the above classes were handled. Among these were 6 cases involving questions of water rights; 8 suits for the cancellation of patents, in one of which a decree of cancellation was entered; 2 by claimants under the public-land laws to enjoin the use of their claims by permittees of the department, one of which resulted in a decree in favor of the permittee and is pending on appeal; 1 to condemn a right of way across two ranches for a road needed by the Forest Service; and 3 to quiet title. A suit to enjoin the register and receiver of the Phoenix land office from proceeding to try and determine charges against the validity of a number of mining locations within the Tusayan National Forest resulted adversely to the plaintiff and was appealed to the Supreme Court of the United States, where it is now pending. A forgery case resulted in the acquittal of the defendant. Two cases involving the destruction of Government property resulted in a fine of \$10 in one and reprimand and release of the defendants, who were minors, in the other. In 4 cases involving theft of Government property two sentences of 30 days in jail and two fines of \$50 and \$25, respectively, were imposed. A criminal prosecution for driving an automobile in the Grand Canyon National Monument, in violation of the regulations, resulted in a fine of \$25. One claim of the United States filed in bankruptcy proceedings was paid and another is pending. A claim filed with the receiver of an insolvent corporation for the balance due on two timber sale contracts was paid. An action for damages for failure to complete a timber sale contract resulted in a judgment for \$31.75 and costs. A prosecution for the homicide of a Forest officer resulted in the acquittal of the defendant.

A suit instituted on recommendation of the Department of the Interior, pending in the United States court for Arizona, is of considerable interest in the administration of the National Forests. Defendant claims by right of settlement 160 acres of land, 120 of which are covered by Wolf Hole Lake, a watering place for sheep being driven from Arizona ranges to the National Forests in Utah. An injunction is sought to restrain defendant, who is alleged to be working in the interests of people desirous of keeping sheep out of the neighborhood, from fencing or draining the lake.

COURT DECISIONS OF INTEREST.

United States v. Morrison (240 U. S., 192), settled the question of title to unsurveyed school land in the National Forests in Oregon. The State of Oregon, claiming title under the grant of sections 16 and 36 in every township made to it by the act of Congress of February 14, 1859 (11 Stat., 383), providing for its admission into the Union, and relying upon a survey executed in the field but not approved by the Commissioner of the General Land Office, had sold to the defendant a portion of one of these sections. This and other adjacent land, after survey in the field but before approval by the Commissioner of the General Land Office, had been withdrawn for forest purposes by the Secretary of the Interior and set apart as a Forest by the President. The court holds that a survey is incomplete until approved by the Commissioner of the General Land Office, and even though approved without modification does not

relate back, as contended by the defendant, so as to defeat the power of Congress to dispose of the land while unsurveyed, that a disposition by the President under authority of an act of Congress is a disposition by Congress, and that the power to establish the Forest included the power to make the temporary withdrawal.

Several important cases have arisen in connection with the administration of the Grand Canyon National Monument within the Tusayan National Forest. Numerous mining locations have been made along the rim of the canyon and at other points of vantage. These locations interfere seriously with the proper administration of the land as a Monument and Forest and also prevent the full and free enjoyment of the beauties of the canyon by the many tourists who visit it annually. In *Cameron v. Weedin and Birdno* (226 Fed., 44), involving 17 of these mining locations, the court denied the plaintiff's application for a temporary injunction to enjoin the defendants (the register and receiver of the United States land office at Phoenix, Ariz.), from proceeding with a hearing ordered by the Commissioner of the General Land Office to determine the validity of the locations. The plaintiff contended that the Department of the Interior was without jurisdiction in the absence of an application for patent, and that in this circumstance the validity of the locations could be determined only by the appropriate court. In dismissing the complaint, the court held that it was without jurisdiction to interfere with the proceedings, since the legal title to the land is in the United States and the defendants were acting under the orders of their superior officers. It also held that if the defendants were without jurisdiction the proceedings were void and no injunction was necessary. An amended complaint was filed, joining the Commissioner of the General Land Office, service being made upon him while temporarily in Arizona. Motions to quash service on the Commissioner and dismiss the amended complaint were granted, and the plaintiff then perfected an appeal to the Supreme Court of the United States, where the case is now pending. The register and receiver proceeded with the hearing and upon completion of the Government's case the claimant refused to introduce any evidence. No decision has been rendered by the register and receiver, since the claimant obtained an injunction against the Secretary of the Interior and the Commissioner of the General Land Office in the Supreme Court of the District of Columbia. An appeal from this decision has been prosecuted to the Court of Appeals of the District of Columbia.

A suit has been filed by the Government in the United States court for Arizona (Prescott E-10), for an injunction to prevent Cameron, the plaintiff in the above-mentioned case, and his tenants from occupying and maintaining numerous buildings on the rim of the canyon and at the head of the Bright Angel Trail, the principal means of access to the bottom of the canyon. Cameron claims the land under a mining location designated as the Cape Horn lode, which was declared null and void by the Secretary of the Interior when he rejected an application for patent therefor. The defendant's motion to dismiss and transfer to the law side of the court was denied, and the right of the Government to proceed in equity for an injunction sustained. The case was set down for final hearing on August 1, 1916.

In *Cameron v. Bass*, mentioned in my last report, involving the Cape Horn claim, the Superior Court of Coconino County, Ariz., re-

fused to enjoin the defendant from occupying the land under a special use permit issued by the Forest Service. The case is now pending before the Supreme Court of Arizona upon the plaintiff's appeal.

The case of *Svan Hoglund v. Franklin K. Lane*, Secretary of the Interior, mentioned in my report for the previous fiscal year, was argued before the Supreme Court of the District of Columbia on July 16, 1915, by the Solicitor of the Department of the Interior and myself. After hearing the argument, the court directed the clerk to enter an order dismissing the petition. This decision was reversed by the Court of Appeals of the District of Columbia, and mandamus directed to issue. The case is now pending on appeal in the Supreme Court of the United States.

In *Utah Power & Light Co. v. United States* (230 Fed., 328), the company appealed from the decree entered by the United States District Court for Utah, quieting and confirming in the United States title to certain lands in the Cache National Forest, and enjoining the company from maintaining and operating thereon certain works for the development of hydroelectric power. The company claimed the right to occupy and use these lands under various acts of Congress and the laws of Utah. The circuit court of appeals, affirming its former decision (209 Fed., 554), mentioned in my report for the preceding fiscal year, sustained the decree of the district court, and, in addition to denying the alleged right of the State to appropriate or authorize the appropriation of lands of the United States by right of eminent domain, held that the act of Congress of May 14, 1896 (29 Stat., 120), which authorized the Secretary of the Interior to issue permits for water-power development, was not superseded by the act of May 11, 1898 (30 Stat., 404), permitting the use for purposes of a public nature of rights of way theretofore or thereafter approved for ditches, canals, or reservoirs for irrigation purposes. The company has prosecuted an appeal to the Supreme Court, where the case is now pending.

IMPORTANT DECISION OF THE ATTORNEY GENERAL.

In an opinion of July 3, 1915, the Attorney General held that National Forest lands withdrawn for the use of the Reclamation Service in the construction of irrigation works should be released from withdrawal when it is determined that they are not needed for that purpose. In the meantime they should be administered as other National Forest lands, subject only to the necessities of the reclamation use.

IMPORTANT DECISION OF THE COMPTROLLER.

On November 9, 1915, the Comptroller of the Treasury held that the sum appropriated for permanent improvements by the act of March 4, 1915 (38 Stat., 1086, 1100), including, among other things, the construction of roads and trails within the National Forests, was available to cover the purchase of a right of way for the construction of a road within the Trinity National Forest.

THE WEEKS FORESTRY LAW (36 STAT., 961).

The acreage acquired under the Weeks forestry law during the fiscal year 1916 was more than double that acquired during the preceding year, and in excess of the total acquired under the act from

the date of its enactment in 1911 to the end of the fiscal year 1915. This result, although accomplished with a smaller force of title attorneys and stenographers in 1916 than in 1915, and at a reduction in the expenses incidental to the work, was due to the increased efficiency of the field force and to more methodical administration made possible by better knowledge of the conditions in the States respecting the titles. The work of examining titles and of the acquisition of lands under this law is up to date. Only such delays as may occur because of defective titles and the necessary incidents of the institution and prosecution of condemnation proceedings need hereafter be anticipated to cause the time consumed in making title reports to be greater than is essential to the orderly examination of the records in the usual course.

During the year three title attorneys resigned. For the reasons that the work of the examination of titles was well in hand and the appropriation for the purposes of the act was about exhausted, the vacancies were not filled. Since an appropriation for the continuance of the work has been made by the act of August 11, 1916 (Public No. 190), as further purchases are authorized by the National Forest Reservation Commission, additional title attorneys will probably be required.

Appended is a summary, in terms of acres, of the operations under the Weeks law from the beginning to June 30, 1916:

State and area.	Purchases authorized (estimated).	Purchases completed (actual survey).	Reports in Department of Justice.	
			For opinion (actual survey).	For condemnation (actual survey).
Georgia:	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Georgia.....	62,095	31,449.99	66.70	27,345.38
Savannah.....	35,827	11,345.86	403.72	20,064.32
Maine: White Mountain.....	24,825			
New Hampshire: White Mountain.....	270,849	195,215.87		38,961.35
North Carolina:				
Boone.....	36,386			
Mount Mitchell.....	76,050	34,817.66	228.57	11,382.87
Nantahala.....	39,903	31,711.41	114.54	1,041.17
Pisgah.....	86,700	49,703.75		
Savannah.....	39,839	16,879.18	13.51	14,798.07
South Carolina: Savannah.....	25,508			17,066.59
Tennessee:				
Cherokee.....	135,976	72,467.69	25,551.09	9,281.20
Smoky Mountain.....	117,113			
White Top.....	57,000	39,167.82	118.40	10,098.58
Unaka.....	49,949		38.70	21,302.44
Virginia:				
Massanutten.....	66,792	23,211.86	8,803.11	13,941.99
Natural Bridge.....	84,071	32,264.96	20,590.52	415.73
Potomac.....	62,334	37,587.59	3,197.59	8,481.42
Shenandoah.....	124,569	84,377.87		18,421.18
West Virginia:				
Monongahela.....	52,610	22,809.74	546.06	18,706.73
Potomac.....	16,319	10,644.80	569.80	1,166.75
Shenandoah.....	(*)	13,318.45		
Total.....	* 1,464,715	706,974.50	60,242.40	232,475.77

¹ 27 387 acres reported in this area on last year's report have since been transferred to the Unaka area.

² Acreage included in the Shenandoah, Virginia, authorizations.

³ 132,488 acres dropped by the Commission subsequent to approval.

This office collaborated with the Department of Justice in the preparation of a bill for the simplification of the procedure in Federal courts for the condemnation of lands. It was introduced in the

Senate and House (S. 6076; H. R. 11957) at the past session, and is pending before the Judiciary Committees of the two bodies. Its passage was requested by the National Forest Reservation Commission, the Attorney General, and yourself. Because of incurable record defects, and in order to secure safe title, up to the end of the fiscal year 1916, it had been necessary to resort to or recommend to the Department of Justice condemnation of more than three-fourths of the lands examined under the Weeks law. The enactment of the proposed legislation would effect a great saving of expense and would much reduce the time between the making of contracts of purchase and the payment of vendors.

THE FOOD AND DRUGS ACT (34 STAT., 768).

Nine hundred and seventy-eight cases were transmitted to the Department of Justice, in 401 of which criminal proceedings and in 577 of which seizures were recommended. The 401 criminal cases embraced 787 alleged violations of the food and drugs act.

At the close of the fiscal year 1915 435 cases were pending, of which 233 were criminal prosecutions and 202 were seizures.

Three hundred and seventy-two cases pending at the close of the fiscal year 1915 and 664 reported during the fiscal year 1916, in all 1,036, were terminated in 1916. Of those terminated 434 were criminal and 602 were civil.

In 330 of the 434 criminal cases fines were imposed; in 3 the informations were placed on file; in 1 the judgment of conviction of the lower court was affirmed; in 1 the court refused leave to file the information; in 6 demurrers to the informations were sustained; in 7 there were acquittals; in 32 there were nolle prosequis; and 54 were withdrawn, dismissed, or barred by the statute of limitations. In a majority of the cases in which fines were imposed pleas of guilty, nolo contendere, or non vult were entered. In 11 pleas of not guilty were entered, and the defendants were convicted after trial.

In the criminal cases in which convictions were obtained, the fines were as follows:

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
1	\$0.06	\$0.06	1	\$45.00	\$45.00
1	1.00	1.00	76	50.00	3,800.00
1	2.00	2.00	7	75.00	525.00
1	2.50	2.50	1	80.00	80.00
13	5.00	65.00	25	100.00	2,500.00
44	10.00	440.00	1	125.00	125.00
13	15.00	195.00	3	150.00	450.00
19	20.60	380.00	14	200.00	2,800.00
84	25.00	2,100.00	1	225.00	225.00
5	30.00	150.00	1	300.00	300.00
1	35.00	35.00	1	350.00	350.00
2	37.50	75.00	1	500.00	500.00
4	40.00	160.00	1	600.00	600.00
			322	.....	15,905.56

¹ In this case there were six counts in the indictment, a fine of \$100 being imposed on the first count and \$125 on the other five counts.

² In this case there were two defendants, one of these being fined \$200 and the other \$100.

³ In this case the court fined the defendant \$175 on each of two counts of the information.

⁴ This fine, with a sentence of imprisonment also imposed, represents a second conviction under the food and drugs act.

⁵ In this case there were three counts in the information and a fine of \$200 was imposed in each.

⁶ This number represents 330 cases reported to the Department of Justice, some of which were consolidated by the United States attorneys for trial.

In addition to the fines imposed, costs were generally assessed.

Of the 602 civil cases terminated during the year decrees of condemnation and forfeiture were entered in 543, of which 6 were decided favorably to the Government after contest; in 17 the libels were dismissed or the proceedings discontinued or dropped with the consent of the Government; in 40 the packages were broken or disposed of before seizure could be made; and in 2 the court decided adversely to the Government after trial. In the 543 cases in which decrees of condemnation and forfeiture were entered the goods were destroyed in 330, released on bond or otherwise in 177, sold in 35, ordered sold or destroyed in 1.

At the close of the year 377 cases were pending, of which 200 were criminal prosecutions and 177 were seizures.

In addition to the cases reported by this department to the Department of Justice, the food and drugs officials of the various States and of the District of Columbia, collaborating with the department in the enforcement of the act, reported 18 cases to the United States attorneys for action. Of these 11 were criminal cases and 7 were seizures. In all of the criminal cases there were convictions. In 3 of the seizure cases decrees were entered and the products either sold or released on bond; in another case a writ of restitution was granted. The 3 remaining seizure cases are pending. The fines in the criminal cases were as follows:

Number of cases.	Amount of fines.	Total.
1	\$5.00	\$5.00
10	10.00	100.00
11	.....	105.00

Six hundred notices of judgment were prepared.

Upon the application of several organizations of merchants, a public hearing was given upon the question whether single hams and single sides of bacon, wrapped or covered with paper, cloth, or gelatine, are "in package form," within the meaning of the net-weight amendment of March 3, 1913 (37 Stat., 732), to the food and drugs act. The matter was still under consideration at the end of the year.

CASES OF INTEREST.

In *United States v. 40 Barrels and 20 Kegs of Coca Cola* (241 U. S., 265; Circular 86, Office of the Solicitor), the Supreme Court reversed the judgment of the United States Circuit Court of Appeals for the Sixth Circuit (215 Fed., 535; Circular 80, Office of the Solicitor), which sustained the judgment of the District Court for the Eastern District of Tennessee dismissing the libel filed by the Government to condemn the article for alleged adulteration and misbranding (191 Fed., 431). The Supreme Court held that the caffeine in Coca Cola is an "added" ingredient within the meaning of the act, and that the questions whether the presence of caffeine may render the article injurious to health, and whether the name "Coca Cola" is false or misleading, are questions of fact for a jury to decide.

In *Seven Cases and Six Cases of Eckman's Alternative v. United States* (239 U. S., 510; Circular 85, Office of the Solicitor), the Supreme Court affirmed the judgment of the District Court of the United States for the District of Nebraska (Notice of Judgment 2995), overruling demurrers challenging the sufficiency of the libels filed and the constitutionality of the Sherley amendment, approved August 23, 1912 (37 Stat., 416), to the food and drugs act.

In *Goode et al. v. United States* (Notice of Judgment No. 3869), the Court of Appeals of the District of Columbia affirmed the decree of the Supreme Court of the District of Columbia (*United States v. Seven Cases of Buffalo Lithia Water*, Circular 78, Office of the Solicitor), condemning as misbranded an article labeled "Buffalo Lithia Water" on the ground that the article did not contain sufficient lithium to entitle it to be labeled "lithia water." The case is now pending in the United States Supreme Court on writ of error.

In *United States v. 25 Bags of Nuts* (Notice of Judgment No. 4329), the product was alleged to be adulterated in that it was wormy, moldy, and unfit for food, and misbranded in that it was labeled "fancy mixed nuts," whereas the nuts were not fancy mixed, but were of an inferior grade. The court refused to permit the Government to introduce the testimony of expert trade witnesses to show that the nuts were not of the grade known as "fancy mixed," and directed a verdict for the claimants.

In *Dr. Williams Pink Pills v. United States* (Circular 87, Office of the Solicitor), the United States Circuit Court of Appeals for the Third Circuit, in affirming the decree of the United States District Court for the Eastern District of Pennsylvania condemning 11 packages of Dr. Williams' Pink Pills for misbranding in violation of the Sherley amendment of August 23, 1912, to the food and drugs act, by reason of the labels bearing false and fraudulent statements regarding the curative or therapeutic effect of the drug, held that if it be established by the evidence that such statements are false, and that they were made with reckless or wanton disregard of their truth or falsity, the article is misbranded within the meaning of the amendment.

Among other cases of interest were the following:

United States v. Harry Matusow (Notice of Judgment 4190).

United States v. Earl Chandler (Notice of Judgment 4547).

United States v. 408 Bu. of Oysters, unreported (F. and D. No. 7036).

United States v. Thomson, Taylor Spice Co., unreported (F. and D. Nos. 2621, 4481, 4774, 4775, and 5014).

THE MEAT INSPECTION LAW (34 STAT., 674).

Two hundred and thirty-seven cases were reported to the Attorney General, while 155 cases were reported during the preceding year, an increase of 82 cases for the fiscal year 1916.

At the close of the fiscal year 1915 65 cases were pending.

Of the cases reported during the fiscal year 1916, 168, and of those pending at the close of the fiscal year 1915, 42, in all 210, were terminated during 1916. One hundred and eighty-eight resulted in convictions, 13 were dismissed, in 8 grand juries failed to indict, and in 1 verdict was rendered for the defendant.

Sentence of imprisonment, amounting to 30 days, was imposed in one case; in another, the defendant was committed to jail pending payment of his fine; while in 4 other cases, consolidated into one, sentence was suspended upon payment of costs by defendant.

Fines aggregating \$3,250 were imposed in 133 cases, as follows:

Penalty.	Number of cases.	Total fines.	Penalty.	Number of cases.	Total fines.
\$5.00	3	\$15.00	\$50.00	14	\$700.00
10.00	18	180.00	55.00	1	55.00
15.00	5	75.00	75.00	3	225.00
20.00	5	100.00	\$100.00	5	500.00
25.00	37	925.00	\$200.00	2	400.00
35.00	1	35.00			
40.00	1	40.00			
				-----	3,250.00

¹ 2 cases were consolidated into one, and fines of \$5 imposed in each instance.

² 2 cases were consolidated into one, and fines of \$20 imposed in each instance.

³ 50 cases were consolidated into two, and two fines of \$25 each were imposed.

⁴ 4 cases were consolidated into two, and fines of \$50 imposed in each instance.

⁵ 5 cases were consolidated into one, and fines of \$100 imposed in each instance.

⁶ 34 cases were consolidated into two, and two fines of \$200 each were imposed.

At the close of the year 92 cases were pending.

CASES OF INTEREST.

In *St. Louis Independent Packing Co. v. Houston et al.* (231 Fed., 779) the district court sustained a regulation of the department under the meat inspection act prescribing the maximum cereal, water, and ice content in sausage. The case is pending in the Circuit Court of Appeals for the eighth circuit on the company's appeal.

In *Pittsburgh Melting Co. v. B. & O. R. R. and Totten* (232 Fed., 694) the Circuit Court of Appeals for the third circuit reversed the decision of the district court and held that "oleo oil" packed in containers stenciled or labeled "Inedible," and accompanied by a certificate stating that it was not intended for food purposes, was a meat food product within the meaning of the meat inspection act.

THE TWENTY-EGHT HOUR LAW (34 STAT., 607).

Four hundred and sixty-five cases were reported to the Attorney General.

At the close of the fiscal year 1915, 1,117 cases were pending.

Of the cases reported during the fiscal year 1916, 78, and of those pending at the close of the fiscal year 1915, 419, in all 497, were terminated during 1916.

Penalties aggregating \$52,450 were recovered in 383 cases. Eighty-three cases were dismissed and 31 were determined adversely to the Government.

The following is a detailed list of the number of cases prosecuted and amounts of penalties assessed:

Number of cases.	Amount of penalty.	Total.	Number of cases.	Amount of penalty.	Total.
1	\$50	\$50	8	\$150	\$1,200
124	200	24,800	1	350	350
1	500	500			
243	100	24,300	383	-----	52,450
5	250	1,250			

One thousand and eighty-five cases were pending at the close of the fiscal year.

DECISIONS OF THE COURTS.

Among the cases of interest, decided during the year, were:

Grand Trunk Railway Co. *v.* United States (229 Fed., 116),

United States *v.* Philadelphia & Reading Railway Co. (223 Fed., 202), and

Northern Pacific Railway Co. *v.* Finch et al. (225 Fed., 676).

ACTS REGULATING THE INTERSTATE MOVEMENT OF LIVE STOCK FROM QUARANTINED DISTRICTS, PROHIBITING THE INTERSTATE MOVEMENT OF DISEASED LIVE STOCK, AND PROHIBITING THE IMPORTATION OF DISEASED LIVE STOCK (23 STAT., 31; 26 STAT., 414; 32 STAT., 791; 33 STAT., 1264).

One case, involving a violation of the act of May 29, 1884 (23 Stat., 31), was reported to the Attorney General. This was dismissed. At the close of the fiscal year 1915, 3 cases were pending; 2 were terminated favorably to the Government, a fine of \$250 was imposed in one and \$300 in the other. At the close of 1916, 1 case was pending.

One case under the act of August 30, 1890 (26 Stat., 414), was reported to the Attorney General. One was pending at the close of 1915. These were pending at the close of the year 1916.

Twelve cases were reported to the Attorney General under the act of February 2, 1903 (32 Stat., 791). At the close of 1915, 15 cases were pending. Nine cases reported during 1916 and 12 pending at the close of 1915, in all 21, were terminated. Sixteen resulted in convictions, upon which fines aggregating \$1,605 were imposed in 15 and sentence was suspended in 1; 4 were dismissed, and 1 determined adversely to the Government. At the close of 1916, 6 cases were pending.

Fifty-four violations of the act of March 3, 1905 (33 Stat., 1264), were reported to the Attorney General. At the close of the fiscal year 1915, 119 cases were pending. Thirty-eight cases reported during 1916, and 97 pending at the close of 1915, in all 135, were terminated. Eighty-five cases resulted in convictions; in 5 cases, grand juries failed to indict; 2 resulted adversely to the Government; and 43 were dismissed. Fines aggregating \$9,525 were imposed in 85 cases. At the close of 1916, 38 cases were pending.

The fines imposed in cases under the animal quarantine laws were:

Number of cases.	Amount of fines.	Total.	Number of cases.	Amount of fines.	Total.
1	\$10	\$10	1	250	250
1	20	20	2	300	600
2	25	50	2	400	800
86	100	8,600			
1	150	150	102	.....	11,680
6	200	1,200			

A great number of orders of the Secretary of Agriculture establishing, modifying, or removing quarantines under section 1 of the act of 1905 were examined as to their legal form and sufficiency. In addition, a number of new regulations were likewise examined.

THE VIRUS ACT (37 STAT., 832).

Thirty-eight apparent violations of the act of March 4, 1913 (37 Stat., 832), governing the preparation, shipment, and importation of viruses, serums, toxins, and analogous products, intended for use in the treatment of domestic animals, were reported to the Attorney General. At the close of the fiscal year 1915, one case was pending. The 38 reported during 1916 and one pending at the close of 1915, in all 39, were terminated during 1916. Twenty-eight were consolidated, and a fine of \$100 was imposed. Three other cases were dismissed. In 7 the defendants pleaded guilty and were fined. In 1 the defendant pleaded nolo contendere and was fined. No case was pending at the close of the year. The fines imposed were:

Number of cases.	Amount of fine.	Total.
1 28	\$100	\$100
1	50	50
7	5	35
36	.....	185

¹ Twenty eight cases against one defendant were consolidated and a fine of \$100 imposed.

THE INSECTICIDE ACT (36 STAT., 331).

Eighty-seven cases were reported to the Attorney General, in 76 of which criminal proceedings and in 11 seizures were recommended. At the close of the fiscal year 1915, 74 cases were pending, of which 71 were criminal prosecutions and 3 were seizures. Fifty-five cases pending at the close of the year 1915, and 48 reported during the year 1916, in all 103, were terminated in 1916. Of the cases terminated, 93 were criminal and 10 civil. In the 93 criminal cases, 8 violations were combined with others for the purpose of prosecution; fines were imposed in 80; sentence was suspended in 1; three were dropped or dismissed; one was nolle prossed. After the combination for purpose of prosecution, in 74 pleas of guilty, and in 7 pleas of nolo contendere were entered.

In the criminal cases in which convictions were obtained the fines were as follows:

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
10	\$5	\$50	1	\$40	\$40
16	10	160	10	50	500
3	15	45	1	75	75
8	20	160	3	100	300
26	25	650			
2	30	60	80	.....	2,040

Costs were assessed in a considerable number of cases in which convictions were obtained. Decrees of condemnation and forfeiture were entered in 10 civil cases. At the close of the year 58 cases were pending, of which 54 were criminal prosecutions and 4 seizures.

During the year 40 notices of judgment were prepared.

THE PLANT QUARANTINE ACT (37 STAT., 315).

No violations were reported to the Attorney General. Nine cases pending at the close of the preceding year are in various stages of prosecution,

A number of proposed orders of the Secretary of Agriculture to establish, and of regulations to enforce, quarantines under the law were examined as to their legal form and sufficiency.

Nine opinions on questions arising under the law were rendered at the request of the Federal Horticultural Board.

Forms were drafted showing information necessary before presenting a case for prosecution and forms for report on the character of the evidence available.

COURT DECISION OF INTEREST.

In *United States v. Adams Express Co.* (230 Fed., 531), it was held that an information charging a violation of the plant quarantine act need not be sworn to where no warrant of arrest is sought; also that where the regulations or notice of quarantine did not specify deciduous nursery stock, shipment thereof without inspection was not a violation of the act.

THE LACEY ACT (35 STAT., 1137).

Fifty-one cases were reported to the Department of Justice. At the close of the preceding fiscal year 37 cases were pending, of which 36 were closed during this fiscal year, 16 by convictions and the imposition of fines, 1 by sentence to three months in jail, 1 by directed verdict of not guilty, and the remainder by dismissal for want of sufficient evidence, inability to identify defendants, and removal of defendants from the district.

Of the 51 cases reported during the year 19 were closed, 15 by convictions and the imposition of fines, 1 by sentence to 13 days in jail, 1 by suspended sentence, and 2 by dismissal. Thirty-three cases were pending at the close of the year.

Fines were imposed as follows:

Number of cases.	Amount of fine.	Total.	Number of cases.	Amount of fine.	Total.
2	\$1.00	\$2	2	\$50.00	\$100
2	2.00	4	3	75.00	225
2	5.00	10	1	200.00	200
6	10.00	60			
4	20.00	80	31	-----	906
9	25.00	225			

In addition to the fines and jail sentences, defendants were compelled to pay substantial costs.

PROTECTION OF BIRD RESERVES LAW (35 STAT., 1104).

There were no prosecutions under this statute during the year.

THE MIGRATORY BIRD LAW (37 STAT., 847).

Twenty-five cases reported during the previous fiscal year were pending at the close of this fiscal year. The case of *United States v. Shauver* (214 Fed., 154), involving the constitutionality of the migratory bird law, which was removed to the Supreme Court of the United States on the Government's writ of error, was argued on October 16, 1915. On February 28, 1916, it was restored to the docket for reargument, and was pending reargument at the close of the year. Owing to the pendency of this case in the Supreme Court,

no violations of the statute were reported to the Department of Justice during the year. Meanwhile, the Department of Agriculture has continued its investigations of violations and, awaiting report to the Attorney General if the Supreme Court decides the Shauver case in favor of the Government, has in hand evidence of a number of violations.

Numerous letters were written in response to requests from various sections of the country for information as to the law and the regulations.

MARKETS AND RURAL ORGANIZATION.

In cooperation with the Office of Markets and Rural Organization, four amendments to the regulations under the United States cotton futures act, amended forms for use in its administration, and drafts of orders and notices establishing and promulgating 11 standards of color for cotton of certain grades were prepared. Assistance was also rendered in preparing opinions, distributed through that office, on various questions arising under the act, and in comparing or revising articles for Service and Regulatory Announcements on the official cotton standards of the United States, a history of the movement to secure universal cotton standards, the determination of disputes under the act, and other related matters.

Assistance was given in the consideration and disposition of 422 disputes under the act, involving 27,200 bales of cotton, referred to the Secretary. Costs aggregating \$9,322.55 were assessed in accordance with the act.

Two suits attacking the validity of the cotton futures act were filed during the fiscal year 1915 in the United States District Court for the Southern District of New York. On October 13, 1915, the court held in the first, *Hubbard v. Lowe* (226 Fed., 135), that the statute was a revenue measure; the bill from which it resulted, within the meaning of Article I, section 7, clause 1, of the Constitution, originated in the Senate, not in the House of Representatives; and the act was, therefore, unconstitutional. The decision in the second followed that in the first. The first case is pending on writ of error in the Supreme Court. A motion by defendants in error to advance it for early argument was denied. The statute, with amendments, was reenacted as Part A of the agricultural appropriation act for the fiscal year 1917, approved August 11, 1916 (Public No. 190).

A compilation relating to future trading in grain, prepared in the Bureau of Plant Industry, was considered and revised.

The legality and form of the plans for the formation and operation of eight cooperative organizations connected with the marketing of farm products were passed upon.

Additional material relating to the general welfare clause of the Constitution was collected for use in complying with the requests of committees or Members of Congress for the preparation of, or reports on, bills upon various questions affecting agriculture.

GENERAL STATUTES.

At the close of the previous year there were pending 16 cases of violations of the general criminal laws of the United States reported to the Attorney General. During the present year 13 such cases were reported to the Attorney General. Of the cases reported this year

and coming over from previous years, 16 were disposed of. Four were abandoned for lack of sufficient evidence; in 2, orders of nolle prosequi were entered; in 1, the grand jury refused to indict; in 1, upon a plea of guilty, the defendant was sentenced to 30 days' imprisonment for threatening Bureau of Animal Industry employees and interfering with the discharge of their duties; in 1, the defendant was discharged, on payment of costs, on account of his mental condition; in 2, the defendants were fined \$100 each; in 2, the defendants were fined \$50 each; in 2, the defendants were fined \$25 each; and in 1, the defendant was fined \$10. In one case, against two defendants, one of the defendants pleaded guilty and was fined \$75. The other defendant has not been apprehended and the case is, therefore, pending as to him. At the close of the year 13 cases were pending in the courts.

PATENTS.

Twenty applications for letters patent on inventions of employees of the department for dedication to the public were prepared and filed. During the year 7 were allowed, and none disallowed.

The following table shows the status of applications on June 30, 1916:

Applicant.	Bureau.	Invention.	Disposition of application.
Orlin R. Rogers.....	Weather Bureau...	Apparatus for recording duration of rainfall.	Pending.
Frank F. Chase.....	Plant Industry...	Gravity fruit separator.....	Do.
Howard C. Pierce.....	Chemistry.....	Poultry-picking frames.....	Allowed.
Wm. H. Mast.....	Forest Service.....	Planting board.....	Do.
Emil G. Boerner.....	Plant Industry...	Device for sampling, mixing, and blending seed, flour, meal, and other like material..	Do.
Herbert C. Gore and Charles O. Townsend.	Chemistry.....	Process for making sirup from sugar beets..	Do.
Marion Dorset and Howard J. Shore.	Animal Industry..	Process for the manufacture of concentrated hog-cholera antitoxin.	Pending
Marion Gilbert Donk...	Chemistry.....	Process for producing high-grade rosin from low-grade rosin.	Do.
Herbert H. Bunzel.....	Plant Industry...	Thermostat.....	Do.
Harrison E. Patten.....	Chemistry.....	Apparatus for impregnating liquids with gas.	Do.
Wm. H. Waggaman.....	Soils.....	Process for manufacturing sulphuric acid..	Allowed.
Edmund B. McCormick	Public Roads and Rural Engineering.	Torsion dynamometer.....	Pending.
George A. Olson.....	Forest Service.....	Process for drying gluten.....	Do.
Leonard R. Ingersoll..	Forest Service.....	Apparatus for measuring the gloss of non-metallic surfaces.	Do.
Harry D. Tiemann.....	do.....	Dry kilns for drying lumber and other moisture-bearing substances.	Do.
Peter A. Yoder.....	Plant Industry...	Sirup evaporator.....	Do.
William R. Ross, Albert R. Merz, and John N. Carruthers.	Soils.....	Concentrated fertilizers.....	Do.
Samuel C. Hood.....	Plant Industry...	Rotary grating machine.....	Allowed.
John H. Clack.....	Forest Service.....	Pack frame.....	Pending.
Paul J. Fox.....	Soils.....	Process for extracting potash and alumina from alunite.	Do.
John F. Barghausen....	Plant Industry...	Interlocking device.....	Do.
John F. Barghausen....	do.....	Machine for gathering crimson clover.....	Do.
Frederick C. Weber and Frank M. Allen.	Chemistry.....	Fish positioning machine.....	Allowed.
Frederick C. Weber and Frank M. Allen.	do.....	Machine for cutting and eviscerating fish..	Pending.
Charles S. Reeves, Provost Hubbard, and Richard H. Lewis.	Public Roads and Rural Engineering.	Process for preparing waterproof paving material.	Do.
Herbert C. Gore.....	Chemistry.....	Process for preserving fruit juices.....	Do.
Thomas B. Lear.....	Animal Industry..	Stamping tool or punch.....	Do.
Jason L. Merrill.....	Office of Markets and Rural Organization.	Method for making flax tow.....	Do.
Ralph B. Adams.....	Forest Service....	Portable telephone.....	Do.

AGREEMENTS FOR THE SEVERAL BUREAUS, DIVISIONS, AND OFFICES.

The following table shows the number of contracts and leaves prepared or examined for sufficiency and proper execution for the various bureaus, divisions, and offices of the department:

Bureau, division, or office.	Contracts.	Leases.	Bureau, division, or office.	Contracts.	Leases.
Bureau of Animal Industry...	14	38	Library.....	1	0
Bureau of Biological Survey...	1	1	Office of Markets.....	1	16
Bureau of Chemistry.....	6	7	Bureau of Plant Industry.....	67	46
Chief clerk.....	2	9	Office of Public Roads.....	15	6
Bureau of Crop Estimates.....	0	1	Bureau of Soils.....	3	6
Office of Entomology.....	5	37	Supply Division.....	2	3
Office of Farm Management.....	1	3	Weather Bureau.....	13	35
Federal Horticultural Board...	0	1			
Forest Service.....	2,120	8	Total.....	2,255	217
Insecticide and Fungicide Board.....	4	0			

There were also prepared 63 bonds, 315 renewals, and 40 notices of terminations of contracts.

PUBLICATIONS OF THE OFFICE.

There was prepared a compilation of all the Federal laws applicable to the creation and administration of the National Forests, annotated by references to decisions of the courts, opinions of the Attorney General, decisions of the Secretary of the Interior and of the Comptroller of the Treasury, and opinions of the Solicitor construing these laws.

The article prepared during the last fiscal year containing a brief statutory history of the Department of Agriculture, with a discussion of the constitutionality of the organic act creating the department and of the various acts of Congress upon which the activities of the department are based, was published in the February and March, 1916, issues of "Case and Comment."

Under the authority of section 4 of the food and drugs act and section 4 of the insecticide act there were issued 640 notices of judgment.

Office circulars were issued containing decisions of the courts in the following cases:

- Armour & Co. *v.* United States (Circuit Court of Appeals, Third Circuit), Circular No. 83.
- Glaser, Kohn & Co. *v.* United States (Circuit Court of Appeals, Seventh Circuit), Circular No. 84.
- Seven Cases and Six Cases of Eckman's Alterative *v.* United States (Supreme Court), Circular No. 85.
- United States *v.* Forty Barrels and Twenty Kegs of Coca Cola (Supreme Court), Circular No. 86.
- Eleven Gross Packages of Dr. Williams Pink Pills *v.* United States (Circuit Court of Appeals, Third Circuit), Circular No. 87.

REPORT OF THE INSECTICIDE AND FUNGICIDE BOARD.

UNITED STATES DEPARTMENT OF AGRICULTURE,
INSECTICIDE AND FUNGICIDE BOARD,
Washington, D. C., September 14, 1916.

SIR: I have the honor to submit herewith a concise report on the work of the Insecticide and Fungicide Board for the fiscal year ended June 30, 1916.

Very respectfully,

J. K. HAYWOOD,
Chairman of Board.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

The Insecticide Act of 1910 was designed to regulate the interstate shipment, and to prevent the importation into the United States, of adulterated and misbranded insecticides and fungicides, and also to control the manufacture and sale of such products in the District of Columbia and the Territories.

INTERSTATE SAMPLES.

During the fiscal year the Board reported to the Solicitor of the department 116 cases presenting alleged violations of law and with recommendations that the facts be transmitted to the Attorney General to institute criminal action or seizure proceedings. Disposition was made of 242 cases by correspondence with the manufacturers. These cases presented violations which were technical only, were not flagrant, or cases in which the manufacturer gave reasonable and adequate explanation of his failure to conform to the provisions of the act. Action was taken to place in abeyance 847 samples, which upon examination and test were shown to be in compliance with the provisions of the law, or were from shipments of the same goods made prior to shipments for which the manufacturer had been convicted and had after citation conformed to the requirements of the law. On June 30, 1916, 87 cases were pending preliminary hearings or before the Board for final action, 316 were held in temporary abeyance pending the receipt of further information or the outcome of prosecutions based on the same product, or correspondence with the manufacturers, and 821 samples were undergoing analysis and test.

The inspectors and sample collectors of the Board, operating throughout the United States, collected 1,487 samples during the

year. A general classification of the articles represented in the collection is as follows:

Samples collected.	Number of samples.	Samples collected.	Number of samples.
Arsenate of lead.....	201	Fish-oil and whale-oil preparations....	14
Arsenate of lime.....	6	Formaldehyde preparations.....	24
Arsenate of zinc.....	5	Insect preparations, household use....	190
Bordeaux mixture and combinations of Bordeaux mixture with insecticides.....	87	Kerosene emulsions.....	5
Chlorinated lime.....	19	Lice and mite killers.....	102
Cyanides and cyanide mixtures.....	3	Lime-sulphur solution and sulphur preparations.....	103
Dips for animals.....	54	Nicotine preparations.....	39
Disinfectants, germicides, bactericides.....	221	Paris green.....	70
Fly preparations for animals.....	37	Pyrethrum and hellebore powders....	52
		Miscellaneous.....	255

IMPORT SAMPLES.

During the year 35 official and unofficial import samples of insecticides and fungicides were collected by the various port laboratories of the Bureau of Chemistry for examination and test by the Board. Disposition was made of 45 samples, 1 official sample being found not adulterated or misbranded, and 5 adulterated or misbranded, or both, and it was recommended that entry to this country be entirely forbidden or that the consignments be released when correctly labeled. The remaining samples were unofficial, 9 of them being found to be adulterated or misbranded, or both, and in these cases it was recommended that future shipments be detained, while 30 were neither adulterated nor misbranded.

In order to show the progress which has been made each year since the enactment of the law, in reducing violations thereof, a statement of official samples of certain commonly used spraying materials was published in the preceding annual report of the Board. It is deemed of interest to repeat this statement and include with it the year 1915:

Percentage of violations.

Shipped interstate year.	Lead arsenate.	Paris green.	Lime-sulphur solution.	Bordeaux mixture and Bordeaux mixture combined with insecticides.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1911-12.....	60	28	94	98
1913.....	30	21	86	71
1914.....	20	19	27	49
1915.....	8	19	14	36

SPECIAL INVESTIGATIONS.

During the course of an investigation to determine how lead arsenates sold in interstate commerce should be labeled, and to obtain scientific information relative to the preparation and properties of the various lead arsenates, the chemists working for the Board have obtained data which have been accepted for publication, under the

titles "The Preparation and Properties of Lead Chlor-arsenate—Artificial Mimetite," and "The Arsenates of Lead," by the American Journal of Science and the Journal of the American Chemical Society. A third paper on this subject is in course of preparation, which will deal further with the chemistry of the arsenates of lead and the arsenates of calcium. A considerable number of new lead arsenates have been prepared and their properties studied, and this study is now being extended to the arsenates of calcium.

A method has been perfected for the determination of arsenic in arsenates and the various insecticidal and fungicidal mixtures containing arsenates, and has been published in the Journal of Industrial and Engineering Chemistry under the title "The Reduction of As^{v} to As^{iii} by Cuprous Chloride and the Determination of Arsenic by Distillation as Arsenic Trichloride."

The investigation started some time ago to discover a chemical method of determining stems in insect powder and establish standards for insect powder, has been continued and has been extended during the past year to include a study of the process of manufacturing insect powder and the composition of the raw material, as well as the finished insect powder prepared under known conditions. It is hoped that from a study of the numerous figures that have now been obtained, satisfactory standards for insect powder can soon be established, which will be of great service in recognizing adulteration or misbranding of this class of goods.

In cooperation with the Bureaus of Entomology and Plant Industry, the entomologists and plant pathologists of the Board have undertaken an investigation of the comparative merits of dust and liquid sprays in the control of insects and diseases. Especial attention will be given to tests of finely ground sulphur in combination with arsenate of lead, with a diluent, as finely ground lime or gypsum. A number of investigations have been carried out by the entomologists of the Board to obtain information necessary in connection with the enforcement of the act, as for example, a study of the action of various chemicals on soil insects; further investigations were made of the value of different pyrethrum powders, tobacco powders, nicotine solutions, etc., when used as sprays, dusts or fumigants. Experiments have been made to determine the action of potassium cyanide and other substances in the control of insects and plant diseases when injected into the tissues of plants.

The scientists of the Board working under the direction of the Bureau of Animal Industry have made an investigation relative to the amount of sulphur present in normal coal-tar creosote oil, such oils being the basis for the so-called coal-tar creosote dips. Investigations relative to the efficacy of certain preparations in the treatment of mange, especially of the demodectic variety, and in the treatment of certain parasitic worm infestations, were of special importance in connection with the enforcement of the law.

REPORT OF THE FEDERAL HORTICULTURAL BOARD.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FEDERAL HORTICULTURAL BOARD,
Washington, D. C., October 3, 1916.

SIR: I submit herewith an executive report covering the administration of the plant quarantine act for the fiscal year ending June 30, 1916.

Respectfully,

C. L. MARLATT,
Chairman of Board.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

FEDERAL PLANT QUARANTINE ACT.

Under the Federal plant quarantine act of August 20, 1912, as amended March 4, 1913, the entry of foreign nursery stock and other plants and plant products into the United States is regulated, and domestic and foreign quarantines on account of plant diseases and insect pests are established and maintained.

ADMINISTRATION AND PERSONNEL.

FEDERAL HORTICULTURAL BOARD.

The personnel of the Federal Horticultural Board remains the same as last year, namely: C. L. Marlatt, chairman, Bureau of Entomology; W. A. Orton, vice chairman, Bureau of Plant Industry; George B. Sudworth, Forest Service; W. D. Hunter, Bureau of Entomology; Karl F. Kellerman, Bureau of Plant Industry. R. C. Althouse, secretary of the board, has charge of the administrative office. J. H. Batt, of the administrative office, has charge of cotton importations.

FEDERAL AND STATE INSPECTION SERVICE.

No material change has been made in the Federal and State inspection service, the Federal work having been under the charge of Messrs. E. R. Sasscer and R. Kent Beattie. The number of State expert inspectors appointed as collaborators was slightly increased during the year owing to the establishment by the State Plant Board of Florida of a port-inspection service, and we now have a collaborator at each of the principal maritime ports of entry in that State. The inspection of plant importations entered at the port of New York from countries without inspection service, and also of potatoes and avocados offered for entry under the regulations requiring inspection at this port, where the great bulk of importations are entered, has been continued by Mr. H. B. Shaw. During the year cotton has also been added to the products requiring inspection, necessitating a permanent inspection force at Boston, where the bulk of the cotton enters, and a considerable increase of this work at New York, N. Y., Newark, N. J., and San Francisco, Cal.

COOPERATION WITH OTHER DEPARTMENTS.

The State Department and the Treasury Department have continued their hearty cooperation in the enforcement of the foreign quarantines, while the Post Office Department has rendered efficient service in the enforcement of both the foreign and domestic quarantines.

While the orders of the Post Office Department, issued at the request of this department, prohibiting the importation of nursery stock and cotton by mail, have been given wide publicity and are now quite generally observed, occasional shipments of nursery stock and cotton are still sent to this country by mail, only to be promptly returned by the postal officials to the point of origin.

TERMINAL INSPECTION OF INTERSTATE MAIL SHIPMENTS OF PLANTS AND PLANT PRODUCTS.

During the year the States of Arizona and Montana availed themselves of the provisions of the act of March 4, 1915, by providing for terminal inspection of mail shipments of plants and plant products originating in other States. California made similar provision last year. All shipments by mail to these States of florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants or plant products in the raw or unmanufactured state, except vegetable and flower seeds, are now subject to inspection by State officials before delivery to the addressee. All plants and plant products shipped under the certification of the Federal Horticultural Board, however, are exempted from such inspection.

REVIEW OF THE WORK OF THE YEAR.

NEW PLANT QUARANTINES.

The domestic and foreign quarantines described below are additional or supplementary to the quarantines previously established.

FOREIGN QUARANTINES.

WHITE-PINE BLISTER RUST QUARANTINE.—Amendment 1 to Quarantine No. 7, promulgated February 29, 1916, forbids the importation into the United States from the Dominion of Canada and Newfoundland of all five-leaved pines and all species and varieties of the genera *Ribes* (currants) and *Grossularia* (gooseberries), known to be intermediate host plants, to prevent the further introduction into the United States of the white-pine blister rust.

INDIAN CORN.—Quarantine No. 24, promulgated April 29, 1916, effective on and after July 1, 1916, amends and supersedes Quarantine No. 21, promulgated March 8, 1915, and prohibits the importation into the United States in the raw or unmanufactured state from Southeastern Asia (including India, Siam, Indo-China, and China), Malayan Archipelago, Australia, New Zealand, Oceania, Philippine Islands, Formosa, Japan, and adjacent islands, of seed and all other portions of Indian corn or maize (*Zea mays* L.), and the closely related plants, including all species of teosinte (*Euchlaena*), Job's tears (*Coix*), *Polytoca*, *Chionachne*, and *Sclerachne*, to prevent the introduction into the United States of certain very serious corn diseases. One of these diseases, *Peronospora maydis*, is, so far as known, limited to maize. It attacks the young plants, causing great damage, in some parts of Java. The disease caused by *Sclerospora sacchari*, first described from Formosa but known to occur also in the Fiji Islands

and Queensland, is also a very destructive parasite which in favorable seasons completely prevents corn from developing any fruit in Formosa. Unlike the Java corn disease, the Queensland leaf stripe disease attacks also sugar cane, upon which it is a destructive parasite. Other mildews seriously destructive to corn occur in British India and in the Philippines. All of these downy mildews are favored by warm, moist weather, such as is considered to be ideal corn-growing weather in the Mississippi Valley; and if these diseases should reach this country and become established in the Mississippi Valley, they would probably cause enormous damage to our most valuable crop.

DOMESTIC QUARANTINES.

HAWAIIAN COTTON.—Quarantine No. 23, revised, promulgated February 11, 1916, effective on and after February 16, 1916, amends and supersedes Quarantine No. 23, promulgated June 11, 1915. This quarantine forbids the movement from Hawaii into or through any other State, Territory, or District of the United States of raw or unmanufactured cotton, except in accordance with the regulations prescribed therein, with the object of preventing the introduction into the continental United States of the pink boll worm (*Gelechia gossypiella* Saund).

GIPSY MOTH AND BROWN-TAIL MOTH QUARANTINE.—Quarantine No. 25, promulgated May 22, 1916, was originally issued November 5, 1912, as Quarantine No. 4, and has been revised and amended annually to embody the annual revision of the territory necessitated on account of the changes in distribution of these two insects. This quarantine defines the districts in New England infested by the gipsy moth and the brown-tail moth, and prohibits the movement in interstate commerce of plants and plant products except in accordance with the regulations prescribed therein. The spread of the brown-tail moth during the year was so slight that it was unnecessary to extend the quarantine line on account of this pest. The spread of the gipsy moth was considerably less extensive than last year.

The inspection and certification of Christmas trees and Christmas greens from the area infested by the gipsy moth was undertaken last year for the first time. The amount of such material for which inspection and certification was requested was much less than had been expected. The authorities of the States of New York and Ohio were, however, unwilling to receive such certified Christmas trees and Christmas greens, and established quarantines against such material originating in the area infested by the gipsy moth, taking this action both on account of the difficulty of inspecting such trees and greens on arrival at destination and as an expression of lack of confidence in any inspection of such masses of material. In point of fact, however, no gipsy-moth infestation has been found on any of the certified Christmas material shipped from infested districts. All shipments of certified products from the areas quarantined on account of the gipsy moth and the brown-tail moth to points outside of these areas are being reported to the proper officials of the States receiving such shipments, so that at destination reinspection may be made by State inspectors if desired.

As in former years, the cost of administering this quarantine was paid out of the special appropriation for preventing spread of moths granted to the Bureau of Entomology.

THE WHITE-PINE BLISTER RUST.

The white-pine blister rust, a most destructive disease affecting five-leaved pines, was the subject of the first quarantine issued under the authority of the plant quarantine act. This quarantine prohibited the entry of certain pines from certain countries in Europe. The increased knowledge of the foreign distribution of this disease made it necessary to revise this quarantine and it was reissued as Quarantine No. 7, May 21, 1913, forbidding the importation into the United States of all five-leaved pines from every country of Europe and Asia. Prior to this quarantine action this disease had gained foothold in New Hampshire, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, New Jersey, Ohio, and Indiana, and it is now known to occur in all of these States except Ohio, Indiana, and New Jersey. In the meantime it had also obtained considerable foothold in Canada.

The States invaded by the white-pine blister rust have been actively engaged for several years, in cooperation with this department, in an endeavor to stamp out the disease, and this action has apparently been successful in the three States last named. The occurrence of this disease in Canada and the fact that its alternate host includes the genera *Ribes* and *Grossularia* necessitated an amendment to Quarantine Notice No. 7. This amendment was promulgated February 29, 1916, forbidding the importation into the United States from the Dominion of Canada and Newfoundland of all five-leaved pines and of all species and varieties of *Ribes* and *Grossularia*.

At the request of the State forester of New York an informal conference was held by the Federal Horticultural Board July 20 with various other State foresters and State nursery inspectors to discuss the white-pine blister rust situation in the United States. The object of the conference was to hear the latest reports on the distribution of the disease and to discuss methods of concerted action by the States and the United States Department of Agriculture in the eradication of this disease.

It developed that the white-pine blister rust was more widespread in the East than had been realized, and it was feared that unless some regulatory action was taken the disease would get beyond control. A public hearing was accordingly held February 4, 1916, to determine the best means of preventing further spread of this disease in this country. Following the hearing, as already noted, a prohibition was placed on the importation of all five-leaved pines and all species and varieties of the genera *Ribes* and *Grossularia* from the Dominion of Canada and Newfoundland.

In view of the known wide shipments of supposedly diseased five-leaved pines from Germany, prior to the establishment of the original quarantine in 1912, it was realized that there was a strong probability that the white-pine blister rust is much more widely distributed in the Mississippi Valley States than has been so far disclosed by inspection. This point of view has since been confirmed by the finding of infections in Wisconsin and Minnesota. The uncertainty as to the distribution of the disease in the United States made it impracticable to take any quarantine action until a thoroughgoing field survey had been made. Such a field survey the Bureau of Plant Industry agreed to undertake at once in cooperation with the board, and this survey is now in progress.

The five-leaved pine districts of the eastern United States have already been invaded or the disease has become so widespread that the further protection of such areas by quarantine is impracticable. There remained, however, the vast five-leaved pine areas of the Rocky Mountain and Pacific slope regions so far uninvaded by this disease and the problem was particularly to protect this area from infection if possible. Inasmuch as no definite quarantine lines could be drawn, the alternative was taken of securing a voluntary agreement from all the nurserymen in the Eastern and Mississippi Valley States not to ship any white pine, currant, or gooseberry stock west of the western line of the following tier of States: North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

LIFTING OF QUARANTINES ON ACCOUNT OF POWDERY SCAB.

The domestic quarantine on account of powdery scab of potatoes was lifted, effective September 1, 1915, by an order issued by the Secretary of Agriculture, August 30, 1915. This action was taken as a result of a thoroughgoing survey conducted by the board of all the principal potato-growing regions of the United States which had been subject to possible contamination by the receipt of seed potatoes from infected districts in Maine and New York or from foreign sources either prior to the establishment of a quarantine or as a result of the movement of certified potatoes. This survey indicated conclusively that the disease is limited by climatic conditions and normally is to be feared only in restricted localities of the northern areas of the United States. The survey made by the board in cooperation with the Bureau of Plant Industry of this department has determined that the disease now occurs, in addition to the previously known regions in Maine and northern New York, in three places in Oregon, one in the State of Washington and five in Minnesota. In view of the impracticability of determining by inspection the complete absence of the disease from commercial shipments of potatoes and the apparently little danger from the shipment of such potatoes to the principal regions where these potatoes find their known markets for food or seed purposes, it was deemed that there was not adequate justification for the continuance of the quarantine restrictions on the movement of potatoes from the infected districts.

A corresponding order lifting the foreign quarantine on account of powdery scab was promulgated December 8, 1915, effective January 1, 1916.

NURSERY-STOCK IMPORTATIONS.

The system of control of imported nursery stock established during the first year of the enforcement of the plant-quarantine act has been continued without material change.

The regulations were revised, effective July 1, 1916. The most important change is the provision that permits to import nursery stock from countries which maintain nursery-stock inspection, and permits to import orchids and tree seeds from countries which do not maintain nursery-stock inspection, instead of being reissued each year as hitherto, will be valid until revoked. This will result in a great saving of clerical labor, and will otherwise facilitate matters both for this office, the offices of the collectors of customs, and the importers and foreign shippers as well.

FOREIGN COUNTRIES MAINTAINING INSPECTION SERVICE.

The following countries have provided for inspection and certification in conformity with the regulations prescribed under the plant-quarantine act:

Australia.	Ireland.	New Zealand.
Barbados.	Italy—Province of Padova	Philippine Islands.
Belgium.	(Padua) only.	Scotland.
Bermuda.	Jamaica.	Union of South Africa.
British Guiana.	Japan.	Spain.
Canada.	Leeward Islands:	Straits Settlements.
Cuba.	Antigua.	Switzerland.
Denmark.	St. Christopher-Nevis.	Trinidad.
England.	Dominica.	Wales.
France.	Montserrat.	Windward Islands:
Germany.	Virgin Islands.	Granada.
Guatemala.	Luxemburg, Grand Duchy	St. Lucia.
Holland.	of.	St. Vincent.

This list includes practically all of the countries which have hitherto maintained any considerable commercial trade in nursery stock with the United States. Any other country may obtain the privilege of commercial exportation to the United States by providing an inspection service.

In general, both importers and exporters of nursery stock have endeavored to comply with the law and to meet all of its requirements. In only one instance was it necessary to revoke permits for the importation of nursery stock due to the infested condition of the stock.

DISTRIBUTION OF IMPORTED NURSERY STOCK, BY STATES.

The following table indicates the distribution by States of nursery stock imported during the fiscal years 1914-15 and 1915-16. It will be noted that in spite of the disturbed conditions in Europe there has been a considerable increase in the amount of nursery stock imported this year over last.

Distribution of imported nursery stock, by States.

State.	Number of cases.		State.	Number of cases.	
	1915-16	1914-15		1915-16	1914-15
Alabama.....	284	241	Montana.....	32	20
Arkansas.....	22	95	Nebraska.....	249	217
California.....	2,403	3,357	Nevada.....	44	1
Colorado.....	152	150	New Hampshire.....	53	53
Connecticut.....	1,972	1,372	New Jersey.....	13,295	8,829
Delaware.....	53	40	New York.....	16,325	12,669
District of Columbia ¹	491	549	North Carolina.....	121	80
Florida.....	1,466	2,461	North Dakota.....	56	12
Georgia.....	191	228	Ohio.....	3,314	3,374
Hawaii.....	57	20	Oklahoma.....	17	15
Idaho.....	4	5	Oregon.....	355	480
Illinois.....	4,671	3,316	Pennsylvania.....	6,096	6,556
Indiana.....	577	569	Rhode Island.....	562	741
Iowa.....	905	1,066	South Carolina.....	41	39
Kansas (north).....	55	51	South Dakota.....	29	16
Kansas (south).....	292	292	Tennessee.....	185	197
Kentucky.....	410	320	Texas.....	151	139
Louisiana.....	279	400	Utah.....	25	27
Maine.....	65	42	Vermont.....	41	24
Maryland.....	595	756	Virginia.....	379	354
Massachusetts.....	4,769	4,221	Washington.....	421	403
Michigan.....	1,325	1,562	West Virginia.....	87	87
Minnesota.....	746	701	Wisconsin.....	509	430
Mississippi.....	21	23			
Missouri.....	513	592	Total.....	64,652	57,192

¹ In addition to the commercial shipments referred to, some 4,600 departmental importations for scientific purposes have been inspected by inspectors of the Federal Horticultural Board.

COUNTRY OF ORIGIN AND NATURE OF NURSERY-STOCK IMPORTATIONS.

Country of origin and classes of plants and seeds imported during the year ended June 30, 1916.

Country.	Fruit trees.	Fruit-tree stocks.	Grape-vines.	Bush fruits.	Roses.	Rose stocks.	Forest and ornamental deciduous trees.	Ornamental deciduous shrubs.
Azores.....	2				35		50	
Belgium.....	305				1,223		3,158	23,818
Bermuda.....			3		5			
Canada.....	58			780	3,544		8	
Cuba.....			15		1		50	
Denmark.....	300				25,525			4,152
England.....	4,301	24	362	70,218	414,174	1,947,800	317,328	20,895
France.....	2,458,194	20,356,416	8,653	31,225	180,461	2,217,804	1,283,817	2,773,821
Holland.....	267,382	160,025	157	33,705	2,375,823	1,065,360	465,098	1,337,606
Ireland.....	150,000			18	104,201	257,500		393
Italy.....	255,007		25				245	277
Japan.....	12,262	10,548	300	1,092	23		26,240	31,210
Norway.....					225			
Scotland.....	384		71	12,591	17,984	389,500	15,462	5,325
Switzerland.....								6
Trinidad.....							90	
Total.....	3,148,195	20,527,013	9,586	149,629	3,123,224	5,877,964	2,111,546	4,197,503

Country.	Coniferous trees other than pines.	Pines.	Ever-green trees.	Evergreen shrubs.	Field-grown florists' stock.	Stocks, cuttings, or seedlings.	Tree seeds.
Australia.....				3	25		<i>Pounds.</i> 28,800
Azores.....				50	2	23	
Belgium.....	89,359		3,649	834,338	110,014		20
Bermuda.....	2			2,800	19,046	3,300	18,554
Brazil.....					16,811		723,012
British Honduras.....					76		50
Canada.....	1,318		109		3,535	12	66
Canal Zone.....					525		
China.....		4					
Colombia.....					24,292		
Costa Rica.....					841		
Cuba.....					407,206		850
Denmark.....					100		
Ecuador.....					1,572		
England.....	14,722		1,018	47,065	31,044	3,794	5,625
France.....	686,346		132,467	339,703	147,439	7,586,632	30,210
Germany.....							82
Guatemala.....					8,206		
Holland.....	1,695,254		70,859	1,322,451	477,818	290,883	
India.....			45		600		
Ireland.....	18						
Italy.....				8		1,909	932
Jamaica.....					12		
Japan.....	9,599	2,172	2,436	14,513	62,064	5,712	3,686
Mexico.....				10	3,060		
New South Wales.....	2						
New Zealand.....					190		
Nicaragua.....					500		
Panama.....					336		2,810
Philippine Islands.....					4,304		
Portugal.....					4		
Salvador.....			26	8			
Scotland.....	10,056		20	3,083	6,576	8,000	
Spain.....					867		
Straits Settlements.....					66		
Trinidad.....				24	59,525		83,809
Venezuela.....					8,423		
Total.....	2,506,676	2,176	210,629	2,564,065	1,395,079	7,900,265	898,536

RESULTS OF STATE AND FEDERAL INSPECTION OF IMPORTED PLANTS AND PLANT PRODUCTS.

INSECT PESTS INTERCEPTED.

As the result of State and Federal inspection, the following pests were intercepted during the year: Egg masses of the gipsy moth on 6 different occasions on stock received from Belgium, France, and Japan. Nests of the brown-tail moth were detected on 6 consignments of nursery stock from France. Egg masses of the European tussock moth (*Notolophus antiqua*) have been repeatedly collected on stock from France, Holland, England, and Denmark. Pupæ of the dagger moth (*Apatela auricoma*) were reported on 12 shipments from Holland. An undescribed potato weevil was collected from Irish potatoes from Peru. This is the fourth potato weevil new to the United States found in potatoes imported from the Andes. The mango weevil (*Cryptorhynchus mangiferae*) was found in a small shipment of mango seed from Siam. This weevil is recognized as a serious pest to mangoes in many tropical countries. Cocoons of the pine sawfly (*Diprion simile*), which is an important pine pest in Europe, were detected on pines from Holland. A second sawfly (*Emphytus cinctus*) was collected on Manetti rose stock on 6 different occasions.

As in previous years, pear seedlings were occasionally found to be infested with the European pear scale (*Epidiaspis piricola*).

In addition to the pear scale, the following is a partial list of the more important scale insects collected on imported stock. The numeral following the country of origin indicates the number of times intercepted:

- Aonidia* sp. on condurango pods from Ecuador (1).
- Aspidiotus palmarum* on coconut from Honduras (1).
- Aspidiotus tsugae* on hemlock from Japan (2).
- Chrysomphalus personatus* on orchids from Canal Zone (1).
- Pseudoaonidia articulatus* on cinnamon from Jamaica (1); on *Pandanus* from Cuba (1); on *Areca* sp. from Trinidad (1).
- Targionia bifornis* on orchids from Panama (1), Colombia (1), Guatemala (1).
- Targionia sacchari* on sugar cane from Cuba (1), and British West Indies (1).
- Chionaspis wistaria* on wistaria from Japan (1).
- Lepidosaphes lasianthi* on camellia from Japan (3).
- Lepidosaphes newsteadii* on umbrella pine from Japan (2).
- Parlatoria calanthina* on olive from Greece (1).
- Parlatoria chinensis* on flowering shrub from China (2).
- Phenacaspis eugeniae* on ornamental plants from China (1).
- Antonina crawii* on bamboo from Japan (2).
- Asterolecanium aureum* on orchids from Isle of Pines (1).
- Lecanium bituberculatum* on *Crataegus oxyacantha* from Holland (1).

In addition to the above, many insects of greater or less importance have been taken on plants of various descriptions. In all, some 193 different kinds of insects have been reported on imported stock during the past year.

DISEASES INTERCEPTED.

Citrus canker has been found on 8 different lots of citrus and related plants—1 from the Philippine Islands, 2 from Java, 1 from Singapore, and 4 from Japan. This is apparently the first time that this disease has been reported from Java and Japan. Seven other diseases of more or less importance have been collected on citrus, appearing on 40 different lots of material. Some of these

diseases are not established in the citrus-growing regions of the United States.

Powdery scab has appeared in 17 lots of potatoes from Peru, 2 from Ireland, and 3 from England. The records from Peru are peculiarly interesting, since this disease occurred on wild potatoes from the east slope of the Andes and clearly indicate that Peru is the home of the powdery scab of the potato.

Nematodes have been detected on plants from Franco, Philippine Islands, Argentina, and China.

In all, some 116 specific diseases of which the causative organism was identified were detected on 185 different kinds of imported plants.

INSPECTION AT PLANT INTRODUCTION GARDENS.

All plant material distributed from Yarrow, Md., was examined and certified at the time of shipment by both entomological and pathological inspectors of the board. The plant material distributed from Chico, Cal., was examined by collaborators of the board. No shipments were made from Miami and Brooksville, Fla., except parcels containing dasheen tubers, chayotes, and fruit.

POTATO IMPORTATIONS.

Potatoes may be imported into the United States from the following countries: Denmark, Holland, Belgium, Cuba, Bermuda, and the Dominion of Canada, these several countries having made representations that adequate field inspection, conducted by recognized experts, have shown freedom from potato wart and other injurious potato diseases and insect pests and having further agreed to examine and certify all potatoes offered for export in compliance with the regulations governing the importation of potatoes into the United States. Canada, having agreed to offer for export into the United States only potatoes free from injurious diseases and insect pests, the examination and certification by the officials of the exporting country have been waived in accordance with the first proviso in regulation 2 of the Regulations Governing the Importation of Potatoes into the United States. All Canadian potatoes are, however, subject to inspection on arrival by an inspector of this board, and entry will be refused to any shipment of potatoes badly infested with disease, even though the disease is one which may already occur in the United States, such as common scab, dry rot, powdery scab, fusarium wilt, and black leg. Provision has also been made for the importation of potatoes from the states of Chihuahua and Sonora, Mexico, and from the island of Santo Domingo without foreign inspection and certification. Importations from Santo Domingo are admitted only through the port of New York, where they are inspected prior to entry. On account of the European war, very few shipments of potatoes were received from the three European countries named.

COTTON IMPORTATIONS.

The order referred to in the report for 1915, regulating the entry of cotton into the United States to guard against the introduction and possible establishment of the pink boll worm and other injurious cotton insects, and the regulations promulgated under said order, became effective July 1, 1915.

All cotton is imported under permit and the ports of entry are confined to the ports where special plants for the disinfection of cotton have been constructed. These ports are: Boston, Mass.; New York, N. Y.; Newark, N. J.; and San Francisco, Cal. The regulations provide further that no imported cotton may be distributed to any person, firm, or corporation not holding an unrevoked license to purchase or use such cotton. By means of a system of reports the board is able to locate until its consumption any bale of cotton imported since June 30, 1915. These regulations do not apply to cotton grown in and shipped from the States of Nuevo Leon, Coahuila, Durango, Chihuahua, Tamaulipas, and Lower California, Mexico.

In February it was brought to the attention of the board that a considerable amount of cotton waste was being imported. Certain grades of this waste, containing the seeds from as many as 20 bales of ginned cotton, are obviously much more dangerous than ordinary ginned cotton. The definition of the term "cotton," as used in the rules and regulations governing the importation of cotton into the United States, was promptly enlarged to include, in addition to ginned cotton, all grades of cotton waste. No disinfection, however, is required of grades of cotton waste resulting from processes in the manufacture of cotton which render it mechanically impossible for them to contain seeds, that is, those grades resulting from and subsequent to the carding machines, and there are no restrictions as to the ports through which such grades of waste may be entered.

Owing to the abnormal conditions obtaining in this country, due to the disturbed conditions in Europe, the completion of a suitable plant for the disinfection of foreign cottons was delayed until early in March. The regulations were then amended by providing that on and after March 10, 1916, all imported cotton must be disinfected at the port of entry as a condition of entry. In the meantime all users of imported cotton were required to screen and safeguard the warehouses in which the cotton was stored and the rooms in which the cotton was handled in the process of opening and cleaning and to destroy by burning all picker waste from such cotton. As now disinfected, the cotton in its original bales is placed in steel retorts accommodating from 50 to 200 bales of Egyptian cotton, and a vacuum of 25 inches is produced. Hydrocyanic-acid gas is then introduced into the retort and after a period of 15 minutes air is introduced into the retort until the vacuum drops to 5 inches. The cotton is then held in this mixture of air and gas for a period of 1 hour and 25 minutes. The mixture of air and gas is then exhausted and the cotton removed. A large series of experiments has demonstrated that the pink boll worm can not survive this treatment. The disinfection at all plants is carried out under the personal supervision of inspectors of this board.

The desirability of preventing the introduction of the pink boll worm into the United States is evidenced by the fact that the last cotton crop in the infested regions of Egypt was reduced about 25 per cent by this insect. The present law in that country is much more drastic than the rules and regulations governing the importation of cotton into the United States, notwithstanding the fact that Egypt is badly infested by the pink boll worm. The plan followed

by the board, however, of having all foreign cottons fumigated on arrival is undoubtedly the only plan which will sufficiently protect the cotton-growing interests of this country and at the same time not impose prohibitive restrictions on the importation and use of foreign cottons necessary in our industries.

The following table indicates the amount of cotton imported during the year and the amount of cotton waste imported since February:

Cotton imported from July 1, 1915, to June 30, 1916, in bales.

Country of origin.	Ginned cotton.	Cotton waste.	Country of origin.	Ginned cotton.	Cotton waste.
Canada.....		625	Japan.....		1,233
Central America.....	1		Java.....	7	
China.....	35,964		Mexico.....		614
England.....		18,167	Peru.....	22,695	
Egypt.....	244,687		Scotland.....		29
Ecuador.....	7		Santo Domingo.....	199	
Haiti.....	5,503		Spain.....		497
India.....	6,902		United States.....	284	
Jamaica.....		4,093			
	11		Total.....	316,260	25,258

All ginned cotton imported since March 10, 1916, is subject to the disinfection requirement. Between March 10, 1916, and June 30, 1916, 119,965 bales were imported, 105,957 bales of which were disinfected on or before June 30, 1916.

Grades of waste resulting from and subsequent to the carding machine are not subject to the disinfection requirement. Between March 10, 1916, and June 30, 1916, 11,872 bales of such grades were imported.

Of waste subject to the disinfection requirement, 5,883 bales were imported between March 10, 1916, and June 30, 1916, 4,968 bales of which were disinfected on or before June 30, 1916.

During the fiscal year 207 packages, etc., of samples of ginned cotton and one package of samples of cotton waste were imported under permit.

The importation of cotton waste was brought under restriction in February, 1916. No record was kept of importations of waste prior to that time.

VIOLATIONS OF THE PLANT QUARANTINE ACT.

A number of small shipments of prohibited foreign plants and plant products were intercepted by customs officials and inspectors of this department, and in each instance the goods were either reexported or destroyed.

On April 11 a telegram was received from the collector of customs at Norfolk reporting that 189 tons of cotton seed from Lagos, West Africa, a part of the cargo of the British steamship *Appam*, brought to Newport News as a German prize of war, was to be sold by an order of the United States Admiralty Court at 10 o'clock the following day. The collector was promptly notified of the quarantine against foreign cotton seed, but the seed was sold to an oil mill in North Carolina, the sale being contingent on the approval of this department. The board, in cooperation with the Office of Markets and Rural Organization, promptly sent experts to Norfolk to safeguard the situation as far as possible. An examination of the seed revealed many traces of infestation by the pink bollworm. Immediate steps were taken to have the provisional sale set aside by the court. This was done as soon as the danger was explained. Several methods of disposing of the very large bulk of cotton seed were considered, with the result that the entire lot was placed in sulphuric acid vats as a preliminary to the conversion of the seed into fertilizer. As additional precautions, the two holds of the *Appam* which had contained the seed were fumigated with a strong dosage of sodium cyanide, and the dock at Newport News was thoroughly swept and

carefully inspected on several occasions to make certain that no scattered seeds remained. While every possible precaution was taken to prevent the introduction of this most serious cotton pest, a careful watch will be kept on the cotton fields in the vicinity of Norfolk during the season.¹ The prompt destruction of the seed after its presence in our waters was known, and the fact that the great majority of the insects had emerged during the long cruise of the *Appam* through the Tropics, very greatly reduced the danger.

REGULATORY INVESTIGATIONS.

The investigations necessitated in connection with our domestic quarantines were confined to a survey for the powdery scab disease of potatoes in the Gulf and Southern Atlantic States and in the States of Wisconsin, Minnesota, Washington, and Oregon, conducted by employees of the board, resulting in the lifting of the foreign and domestic quarantines on account of this disease; the completion of the investigation of the pink bollworm in Hawaii commenced last year by one of the entomological assistants of the Bureau of Entomology, as a result of which the cotton regulations were modified, and the annual scouting to determine the spread of the gypsy moth and the brown-tail moth in the New England States, leading to the quarantining of a number of additional towns on account of the gypsy moth and the elimination from the quarantine of a few towns included last year and which were found to be free this year.

LIST OF PLANTS AND PLANT PRODUCTS COVERED BY QUARANTINE.

The following is a complete list of the plants and plant products now under quarantine in accordance with the various notices of quarantine issued up to June 30, 1916:

FOREIGN.

Irish potatoes from Newfoundland, the islands of St. Pierre and Miquelon, England, Scotland, Wales, Ireland, Germany, and Austria-Hungary, on account of the disease known as potato wart. There are no restrictions on the entry of foreign potatoes into the island of Porto Rico.

Cotton seed (including seed cotton) of all species and varieties and cottonseed hulls from all foreign localities and countries except the States of Nuevo Leon, Tamaulipas, Coahuila, Durango, Chihuahua, and Lower California, Mexico, on account of the pink bollworm. Cotton seed (including seed cotton) of all species and varieties from the Mexican States mentioned may be imported under permit and bond for manufacturing purposes only. No restriction is placed on the use of cottonseed hulls imported from said States or which may be obtained from cotton seed imported from said States.

Seeds of avocado or alligator pear from Mexico and the countries of Central America, on account of the avocado weevil.

¹ Inspection conducted by the Bureau of Entomology of cotton fields within a radius of 20 or 25 miles of Norfolk in September, 1916, failed to show any signs of the pink bollworm.

Oranges, sweet limes, mangoes, *Achras sapotes*, peaches, guavas, plums, and grapefruit, and their horticultural varieties, from Mexico, on account of the Mexican fruit fly.

All citrus nursery stock, including buds, scions, and seeds, from all foreign localities and countries, on account of the citrus canker and other dangerous citrus diseases. The term "citrus" as used here includes all plants belonging to the subfamily or tribe *Citratæ*.

Living canes of sugar cane, or cuttings or parts thereof, from all foreign countries, on account of injurious insects and fungus diseases of sugar cane. There are no restrictions on the entry of such material into Hawaii and Porto Rico.

All five-leaved pines, currant, and gooseberry plants from the Dominion of Canada and Newfoundland; all five-leaved pines from Asia, and all pines from Europe, on account of the white-pine blister rust and the pine-shoot moth.

Seed and all other portions of Indian corn or maize, and the closely related plants of teosinte (*Euchlaena*), Job's tears (*Coix*), *Polytoca*, *Chionachne*, and *Sclerachne*, in the raw or unmanufactured state, from southeastern Asia (including India, Siam, Indo-China, and China), Malayan Archipelago, Australia, New Zealand, Oceania, Philippine Islands, Formosa, Japan, and adjacent islands, on account of the downy mildews and *Physoderma* diseases of Indian corn.

DOMESTIC.

Cotton seed and cottonseed hulls from Hawaii, on account of the pink boll worm.

Any fruit or vegetable from Hawaii upon which the Mediterranean fruit fly or the melon fly breeds, or which, from proximity of growth or the requirement of packing and shipping, may carry infestation, including alligator pears, bananas, carambolas, Chinese ink berries, Chinese oranges, Chinese plums, coffee berries, cucumbers, damson plums, eugenias, figs, grapes, grapefruit, green peppers, guavas, kamani nuts, kumquats, limes, loquats, mangoes, mock oranges, mountain apples, melons, Natal or Kafir plums, oranges, papayas, peaches, persimmons, pineapples, prickly pears, rose apples, star apples, string beans, squashes, and tomatoes, on account of the Mediterranean fruit fly and the melon fly, except that bananas and pineapples may be moved from the Territory of Hawaii in manner or method or under conditions prescribed in the regulations of the Secretary of Agriculture.

Cotton lint from Hawaii may be shipped to the continental United States only in accordance with the regulations prescribed in the notice of quarantine, on account of the pink boll worm.

Living canes of sugar cane, or cuttings or parts thereof, from Hawaii and Porto Rico, on account of injurious insects and fungus diseases of sugar cane.

Date palms or date-palm offshoots from Riverside County, Cal., east of the San Bernardino meridian; Imperial County, Cal.; Yuma, Maricopa, and Pinal Counties, Ariz.; and Webb County, Tex., shall be moved only in accordance with the rules and regulations applicable thereto, on account of two injurious scale insects, known as the *Parlatoria* scale and the *Phoenicococcus* scale.

(1) Coniferous trees, such as spruce, fir, hemlock, pine, juniper (cedar), and arbor vitæ (white cedar), known and described as "Christmas trees," and parts thereof, and decorative plants of the towns and territory quarantined for the gipsy moth (certain parts of New England), such as holly and laurel, known and described as "Christmas greens or greenery"; (2) forest plant products, including logs, tan bark, posts, poles, railroad ties, cordwood, and lumber; and (3) field-grown florists' stock, trees, shrubs, vines, cuttings, and other plants and plant products for planting or propagation, of the towns and territory quarantined for the gipsy moth (certain parts of New England), excepting fruit pits, seeds of fruit and ornamental trees and shrubs, field, vegetable, and flower seeds, bedding plants, and other herbaceous plants and roots, shall not be moved or allowed to move interstate to any point outside the quarantined towns and territory, or from points in the generally infested area to points in the lightly infested area, unless and until such plants and plant products have been inspected by the United States Department of Agriculture and certified to be free from the gipsy moth and the brown-tail moth.

Deciduous trees and shrubs, or such parts thereof as bear leaves, of the towns and territory quarantined for the brown-tail moth only (certain parts of New England), including all deciduous field-grown florists' stock, vines, cuttings, grafts, and scions, but excepting forest-plant products, such as logs, tan bark, posts, poles, railroad ties, cordwood, and lumber, shall not be moved or allowed to move interstate to points outside the quarantined towns and territory unless and until such plants and plant products have been inspected by the United States Department of Agriculture and certified to be free from the brown-tail moth. Coniferous trees and other evergreen trees are not covered by the brown-tail moth regulations

REPORT OF THE CHIEF OF THE OFFICE OF MARKETS AND RURAL ORGANIZATION.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF MARKETS AND RURAL ORGANIZATION,
Washington, D. C., September 15, 1916.

SIR: I have the honor to transmit herewith a report of the work of the Office of Markets and Rural Organization for the fiscal year ended June 30, 1916.

Respectfully,

CHARLES J. BRAND, *Chief.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

Although the work of the Office of Markets and Rural Organization has increased greatly during the fiscal year, it has been conducted along the four principal lines shown in the preceding annual report of this office: (1)-Marketing and distributing farm products; (2) rural organization investigations; (3) investigation and demonstration of cotton standards and cotton testing; and (4) enforcement of the United States cotton futures act. All of these lines are further subdivided in organization, work has been completed in each line with resulting publications, and further work is in progress as here reported.

MARKETING AND DISTRIBUTING FARM PRODUCTS.

The work under this general classification has been conducted along the same general lines as reported last year and under the same project leaders.

COOPERATIVE PURCHASING AND MARKETING.

All of the work previously reported under this item has been continued in response to the evident need under the joint direction of Mr. C. E. Bassett and Mr. Clarence W. Moomaw. This work includes the study of problems connected with cooperative purchasing and marketing, the giving of aid both in person and by correspondence to groups who wish to organize for such purposes, assistance in the reorganization of associations, the study of existing State laws on cooperation, and work on proposed laws to encourage cooperation. Drafts of the proposed new laws have been submitted to State authorities and are being revised in accordance with their criticisms. All work of a legal nature mentioned in this report has been done in active collaboration with the office of the solicitor.

NATURE OF RESULTS.

It is impossible to estimate the financial benefit which this work accomplishes, but concrete examples are on file in which the saving to growers of a single organization is estimated at not less than \$25,000 the first year. Yearbook Separate 658, the Cooperative Purchase of Farm Supplies, has been published.

ESTABLISHMENT OF A FRUIT GROWERS' AGENCY.

Taking into consideration the amount of territory included, the extent of the industry, and the obstacles to be overcome, probably the most important attempt at federating the farmers' marketing business ever undertaken in this country was prosecuted during this fiscal year and resulted in the formation of a federation of the leading fruit shipping associations and individual shippers of Washington, Oregon, Idaho, and Montana. Members of this federation handle approximately 75 per cent of the fruit products of a section that represents an investment of fully \$150,000,000.

MARKET BUSINESS PRACTICE.

With a view to influencing and securing the introduction of better business methods in agriculture the work relating to market business practice has been prosecuted under the direction of Mr. W. H. Kerr and has been extended to include several industries other than those reported upon last year.

GRAIN ELEVATORS.

The department's uniform system of accounts was installed in about 350 elevators during the year. Advice on business methods and accounting was rendered to elevators in eight States, and systems have been installed to a small extent in five other States without assistance by this office. The rapid growth in the use of the system demonstrates its success and the tendency toward its adoption as the standard accounting system for grain elevators.

In order to expand this work, which was originally confined to cooperative elevators, the system of accounts was adjusted to meet the requirements of the independent companies. Large numbers of private elevators have installed this grain system since the issuance of Bulletin 362, A System of Accounts for Primary Grain Elevators. A marked reduction of expense in operating the accounting departments, together with more accurate and complete information, compensates the concerns for the expense or difficulty incurred in installing the system.

Some grain elevators conduct a lumber business as a side line and for such elevators the office has issued Markets Document No. 2, Lumber Accounting and Opening the Books in Primary Grain Elevators, thus making available to lumber dealers a simple method of accounting in their business.

A method of adaptation for farmers' grain-elevator companies to the patronage-dividend basis was worked out for such elevators as are properly under the jurisdiction of a cooperative law. This

material was issued as Department Bulletin 371, Patronage Dividends in Cooperative Grain Companies, and a large number of companies are now using the methods devised by this office for determining and prorating patronage dividends.

The office has carried on a series of tests with relation to costs in the operation of primary grain elevators. This work has been conducted through the medium of the cost-analysis sheet, included in the grain-elevator accounting system, and from this material a standard of operating costs is being prepared which can be used by elevators generally as a basis of operation.

FRUIT AND PRODUCE ASSOCIATIONS.

The systems of accounts devised by this office for cooperative fruit associations and produce exchanges have been installed by numerous new and old organizations during the year. About 50 concerns are now using these records. Assistance was rendered organizations in Michigan, New Jersey, and Virginia with regard to business methods in accounting.

As an aid to the success of the fruit growers' federation already mentioned, the market business specialists of the office conducted investigations relative to the present accounting methods and perfected a uniform account sales which has been adopted by the sales agents, who are members of the agency. A complete accounting system for local fruit associations is being perfected. The system will be installed by eight organizations in Washington. Cost records will be installed in community packing houses and in orchards where the fruit is packed on an individual basis.

LIVE STOCK SHIPPING ASSOCIATIONS.

The system of accounts for live-stock shipping associations was installed experimentally in three organizations during the year and has been published in Department Bulletin No. 403. There is a large demand for such a system of accounts, and indications are that its installation will be effective in many associations throughout the stock-raising belt within a short time.

COUNTRY CREAMERIES.

A uniform system of accounts for country creameries, which was in an experimental stage during the past year, is now practically in final form to be recommended to these organizations generally for adoption. The system is in operation in five creameries and will be published as soon as possible. Over 50 creameries have requested the printed form.

COOPERATIVE STORES.

A survey has been made of conditions surrounding the organization and maintenance of cooperative stores, in cooperation with the Oregon Agricultural College. The results show that, as a general rule, the cooperative store is an unstable business venture. To improve the condition of these stores a uniform system of accounting records and business methods was devised in cooperation with the college. The results of the two lines of work have been published in bulletin form, Bulletins Nos. 394 and 381.

COMMISSION HOUSES.

Investigations relating to present accounting and business practices of firms engaged in handling agricultural products on a commission basis were continued during the year. Material has been collected which will be used as a foundation for devising a uniform system of accounts for commission houses.

COTTON WAREHOUSES.

Cooperating with the investigators in cotton warehouse problems, a system of accounts for cotton warehouses has been devised and will be placed before the public as soon as practicable.

MARKET SURVEYS, METHODS AND COSTS; FRUITS AND VEGETABLES.

A large part of the work of market surveys regarding fruits and vegetables, which is under the direction of Mr. Wells A. Sherman, dealt with the collection and dissemination of market news on several of the more important perishable crops. As a result, general investigational work has been subordinated, but certain important lines of such work have been developed.

REPORTS OF SHIPMENTS.

During the fall of 1915 plans were laid for securing by mail reports of the carload movement of all fruits and vegetables moving in the United States. Post-card forms were prepared, and early in the spring of 1916 supplies of these cards were forwarded to the station agents of practically all the railroads in the United States which had signified their willingness to cooperate. This work necessarily began in a small way, but is rapidly assuming the magnitude which might be expected. Reports are being received from 225,000 miles of railroad out of a total of 260,000 miles in the United States. Approximately 150,000 carload lots of fruits and vegetables were reported during the months of April, May, and June. The information secured from the railroads is tabulated and will be used as a basis for detailed study and the planning of investigations. Parts of it will be issued to the public from time to time.

One study based on reports from the railroads is now in press as Department Bulletin No. 401: The Marketing and Distribution of Western Muskmelons in 1915.

NORTHWESTERN APPLE SURVEY.

A survey of the Northwestern apple industry was conducted during the fall and early winter months of 1915. Extensive field investigations were made in the States of Washington, Oregon, Idaho, and Montana, with a view to securing as comprehensive information as possible concerning the entire Northwestern fruit industry. Data were secured from growers' associations, shipping organizations, and railroad officials, and the information thus secured has been assembled, tables have been prepared, and charts and graphs have been made. A great deal of the information has been made available to those interested.

Other work prosecuted in connection with the market surveys has been of use in the publication of apple-storage reports described elsewhere.

THE DEMONSTRATION MARKET NEWS SERVICE.

The experimental market news service, which was inaugurated in a small way during the spring of 1915, has been gradually expanded to include several new crops, an additional number of stations in producing territory, and an increased number of permanent city offices. It is conducted under the supervision of Mr. Wells A. Sherman.

Twenty-six temporary field stations have been established in producing territory for the purpose of furnishing the latest market news to the growers of strawberries, tomatoes, peaches, cantaloupes, watermelons, early potatoes, and onions. Permanent city branch offices have been located in New York City, Boston, Philadelphia, Pittsburgh, Chicago, Minneapolis, St. Louis, and Kansas City. Temporary arrangements were made to receive market reports from Columbus, Cleveland, Cincinnati, Detroit, Indianapolis, Milwaukee, Des Moines, and Omaha. The field of action covered more than half the States and reports were issued on radically different types of commodities, ranging from the highly perishable strawberry crop to the semistaple onion and potato crops.

Daily reports on the crops were issued from 10 city offices, which have mailing lists ranging from 100 to 500, and from 22 temporary field offices which have mailing lists ranging from 50 to over 1,500. By far the greater number of reports have been sent out from field offices in producing territory, since it has been found that the best results can be obtained from work done by representatives of this office in producing areas who are able not only to distribute reports but to interpret them and bring the information closer to the shipping public.

The market news service apparently has had as satisfactory results as last year. Among the ways in which the market news service has been most valuable is in assisting growers' organizations to plan selling campaigns intelligently, in promoting better understanding between growers, shippers, commission merchants, and consumers, and in enabling growers to have an accurate check on daily f. o. b. prices.

MARKET GRADES AND STANDARDS.

Work on market grades and standards, which is conducted under the direction of Mr. C. T. More and Mr. W. M. Scott, has been directed chiefly toward improvement in methods of handling perishable products from the field to the market and toward standardization of grades and packages for such products. A study of the conditions in the field and of the requirements of the markets has enabled the Office of Markets and Rural Organization to render assistance to State and national organizations in drafting standardization laws and rules and regulations concerning the grading, packing, and marketing of perishable products.

HANDLING, GRADING, AND PACKING INVESTIGATIONS.

Extensive and thorough investigations have been made concerning the methods of harvesting, handling, grading, packing, inspecting,

and loading strawberries, peaches, tomatoes, boxed and barreled apples, Irish potatoes, sweet potatoes, and Texas Bermuda onions. Sufficient valuable information has been obtained to enable the Office of Markets and Rural Organization to advise growers concerning the best methods of preparing these products for market, and to make possible the preparation of bulletins on the commercial grading and packing of several crops. Farmers' Bulletin 707, *The Commercial Grading, Packing, and Shipping of Cantaloupes*, has been issued during the year, and another bulletin relating to the commercial handling, grading, and marketing of potatoes is in press.

In connection with the investigation of the handling of apples, special study has been given to the picking, handling, and packing of eastern barreled apples and to the practicability of community packing houses, their arrangement, equipment, and sizing machines. This study must be carried much further in order to obtain complete information.

STUDY OF PACKAGES OR CONTAINERS.

The collection and study of packages and containers now in use in the marketing of fruits and vegetables has been continued. The study includes the specifications and capacity and information regarding the making, material, and desirability of each. Boxes, barrels, crates, baskets, hampers, and lug boxes are among the kinds of containers collected and studied.

LEGISLATION REGARDING STANDARDIZATION.

The Office of Markets and Rural Organization has devoted much time to gathering data, making tests of packages, and furnishing suggestions, information, and assistance regarding standardization. Rhode Island has recently established a standard bushel box for the marketing of truck crops. A bushel sweet-potato crate has been adopted by Arkansas shippers. Congress has established the 2, 4, and 12 quart sizes as standards for the shipment of grapes and other fruits and vegetables in Climax baskets and also the dry measure one-half pint, pint, and quart and multiples of the dry quart as standards for baskets or other containers for small fruits, berries, and vegetables. Maryland recently enacted an apple grading and packing law, and Virginia and Pennsylvania are considering similar laws. In all of these cases this office has rendered assistance or furnished advice on request.

PREPARATION OF TEMPORARY GRADES.

The office was called upon to assist in the establishment of temporary grades for the shipment and marketing of sweet potatoes from several of the sweet-potato districts of Arkansas. Several investigations were made in sweet-potato houses in different parts of the State and conferences were held with some of the leading growers, resulting in the adoption by the Russellville growers of tentative grades suggested by this office. They have also adopted a slat crate, having a capacity of one struck bushel, or 2,150.42 cubic inches, at our suggestion.

An investigation was conducted of the field handling, grading, packing, and marketing of Texas Bermuda onions with an especial view toward determining what would constitute practicable grades for this crop. As a result of the field study the following grades were recommended for this crop and approved at a meeting of growers and dealers at Laredo, Tex.: Fancy, choice, jumbo, boilers, and culls.

A field-run test in many different fields in each section gave the grand average for all tests of 50.32 per cent fancy, 22.93 per cent choice, 3.34 per cent jumbo, 7 per cent boilers, and 16.42 per cent culls.

TRANSPORTATION AND STORAGE.

The services of the transportation specialists, under the leadership of Mr. G. C. White, are in constant demand by many, if not all, of the groups of workers who are prosecuting the other lines of work of the office. The information and personal assistance furnished by the transportation section have been of benefit in the establishment and development of the demonstration market news service and have been indispensable to certain lines of investigation regarding the marketing of live stock and meats and other subjects.

The transportation section has demonstrated that its chief value lies in its function of being the traffic department for the entire Office of Markets and Rural Organization, conducting all negotiations with carriers, other than those of a strictly accounting or regulatory nature.

STUDY OF LOSS OF FOODSTUFFS IN TRANSIT.

The economic loss of foodstuffs in transit is increasing constantly. Much of it is due to defective methods of harvesting, packing, and loading, and to the use of insecure and improperly constructed containers. Some of it is caused by inefficient refrigeration in transit and other faults of the present system of transportation. Much of the waste can and should be eliminated. It can never be eliminated entirely, nor can it be reduced to any considerable extent, without a thorough understanding on the part of both shippers and carriers of the difficulties confronting each other. Cooperation between the two in this respect is always essential, but the limitations of the carriers at their terminals in some of the large marketing centers as regards both space and time make the situation one calling at times for an unusual degree of cooperation on the part of shippers with the carriers.

In furtherance of the work undertaken last year to reduce this loss in part through the improvement of their methods, by shippers and distributors, the cooperation of the freight-claim agents of the country was solicited and every opportunity was used to study the problem at terminal markets. In connection with this phase of the work meetings of railroad officials called to consider the subject were attended at Jacksonville, Norfolk, Chicago, and New York.

The officials gave their cordial support not only to this line of work, but to every phase of the work of the Office of Markets and Rural Organization which involves the railroads. The results are highly encouraging, and great assistance has been secured from the railroads, especially in connection with the market news work.

In addition to participation in conferences of railroad officials, in July, 1915, the members of the transportation section, in cooperation with representatives of the Bureau of Chemistry and representatives of the Bureau of Plant Industry, railroad representatives and water-melon distributors, undertook investigations in southern Georgia of the cause of the high percentage of loss and deterioration of water-melons while in transit from southern fields to northern markets. The work was carried to a conclusion, resulting in the discovery that the cause of the loss and deterioration was a stem-rot disease.

STORAGE.

Reports of the cold-storage holdings of apples in the United States, which were first issued during the winter of 1914-15, were continued throughout the past year. On about the 7th of each month reports were issued showing the storage apple holdings on the 1st of the month, together with comparisons of previous holdings. At the end of the season 465 cold-storage firms, out of a total of 500 listed on our records, had furnished the complete cold-storage history of 5,812,496 barrels, showing the amounts and percentages moving from cold storage monthly. The monthly statements compiled from information contained in these reports were furnished to a mailing list of 7,000 names, consisting largely of apple growers, cold-storage firms, transportation officials, and commission merchants. At present the demand for cold-storage information is taxing the resources of the office.

The appointment of a specialist in storage has been made, and the work has been extended to include butter, eggs, cheese, and other products. Telegraphic releases through the press associations and mail reports have been made on butter and eggs, which include the holdings of these products, and comparisons with the holdings on the 1st day of each month with those on the same date of the previous year.

It is planned to develop these storage investigations and increase the number of products reported as rapidly as practicable.

CITY MARKETING AND DISTRIBUTION.

The work for cities to improve their marketing conditions and the studies of market buildings and market places has continued, under the direction of Mr. G. V. Branch.

SERVICE WORK FOR CITIES.

The demand for assistance in improving local marketing conditions has increased during the year. Upon request surveys have been made in the following cities, in order that advice might be given with reference to the location, establishment, and management of municipal retail public markets, or such markets combined with farmers' wholesale market places: Providence, R. I.; Kalamazoo, Battle Creek, Muskegon, Ludington, and Manistee, Mich.; Memphis, Tenn.; East Liverpool, Ohio; and Wilmington, Del. Acting upon advice and suggested plans given by the Office of Markets and Rural Organization in 1915, Huntington, W. Va., established a public retail market of the combined open-shed and inclosed building type during the past year.

In Cincinnati, Ohio, an extensive study was made of the possibilities of a wholesale terminal market which would allow all shipments of farm products to be concentrated and efficiently handled at one point. The report submitted is being used as a basis for educational work designed to bring about improvements in the city's wholesale marketing facilities.

At the request of the wholesale produce trade in Pittsburgh, Pa., investigators spent several weeks in that city during the spring months, studying conditions existing in the 500-car produce yards, where practically all farm products not locally grown are received and sold directly from the car door to jobbers and retailers. Although such facilities appear ideal, the cost of doing business in the yards is unusually high, and it was with the hope that economies might result and more stable conditions be brought about that a disinterested study of the question was desired. The survey was productive of a large amount of useful information regarding the needs of a large terminal market for produce, and it is believed that the report soon to be issued may be instrumental in bringing about greatly improved methods in Pittsburgh's wholesale center.

STUDIES OF MARKET BUILDINGS AND MARKET PLACES.

In order that the advice given to cities may be both sound and practical it has been necessary to continue in greater detail the investigations into all phases of public and wholesale terminal market activity. These investigations have included 15 cities in 8 States. In most of these places special studies were made of proper refrigeration facilities in public markets, correct shed, stall, and aisle layouts, special appliances and general equipment for the most efficient handling of perishable produce and desirable sanitary arrangements.

PRACTICAL PLANS FOR MARKET BUILDINGS AND EQUIPMENT.

It was found that the advisory service rendered to cities which desired to improve their marketing facilities gave incomplete satisfaction so long as the office could not submit model plans for various types of market buildings, open sheds for producers, produce yards, etc., together with fairly accurate estimates of their costs. The services of a qualified technical worker were secured during the past fiscal year to develop this line of endeavor. In addition to carrying out the investigations outlined, a model design for a public retail market has been finished and the cost, fully equipped, has been estimated on a square-foot basis. Model steel sheds to protect local truck growers in selling their products on open farmers' markets have been designed and their costs figured per lineal foot. Rough plans for public market layouts to fit the peculiar conditions of certain cities have been drawn up.

MARKETING BY PARCEL POST AND EXPRESS.

There has been no material change in the methods pursued in the investigations of the possibilities of direct marketing by parcel post. The work, which is under the direction of Mr. Lewis B. Flohr, is of two kinds: (1) Experimental shipments and (2) field studies.

EXPERIMENTAL SHIPMENTS.

Experimental shipments to the number of 1,825, aggregating a weight of almost 39,000 pounds, were made by parcel post and by express over distances totaling 530,756 miles. The commodities shipped include apples, peaches, pears, plums, berries, cherries, citrus fruits, pineapples, maple sirup, cane sirup, honey, nuts, eggs, butter, assorted vegetables, meat, and poultry. Some of the observations made during these shipments resulted in the publication of Farmers Bulletin 703, *Suggestions for Parcel Post Marketing*.

The work done in experimental shipping of farm products indicates that it is physically possible to ship almost any commodity by parcel post when packed and handled according to postal regulations, but emphasis can not be placed too strongly on the necessity for the producers to grade and standardize their products and to use suitable containers. The price which can be obtained by marketing through other channels is a factor in determining the desirability of this method of marketing.

FIELD STUDIES.

Field studies were made in Boston, Lynn, and Lawrence, Mass.; Providence, R. I.; Birmingham, Ala.; New Orleans, La.; Baltimore, Md.; Washington, D. C.; and Chicago, Ill., to ascertain the possibilities of direct marketing from producer to consumer and to determine the relative success of the farm-to-table campaign instituted by the Post Office Department in cooperation with the postmasters of these cities.

A campaign to foster and promote direct marketing by parcel post is now being conducted at Pittsburgh, Pa., in cooperation with the post-office officials there.

COTTON HANDLING AND MARKETING.

COOPERATIVE HANDLING AND MARKETING OF COTTON.

Studies regarding the cooperative handling of cotton and the advantage to the farmer of knowing the grade of his cotton before sale have been continued in North Carolina and Arkansas. The results of the study in North Carolina, which are applicable to many other States in the South, have been prepared for publication.

The cotton classified at Camden, Ark., in the course of these studies was accepted as collateral on the basis of 6 per cent when the legal rate is 10 per cent for the State. It is estimated that it was worth approximately 62 points, or \$3.10 per bale, for the farmer to know the classification of his cotton before sale. Similar work was done in Alabama, South Carolina, and Texas.

In cooperation with the Bureau of Plant Industry, further cooperative work has been conducted in the handling and marketing of cotton in the Imperial Valley, Cal. Improved marketing conditions have been developed, relative values of different staple lengths emphasized, and direct connections made with southern and New England buyers and dealers.

STUDY OF THE PRACTICE OF SELLING COTTON IN THE SEED.

The study of the practice of selling cotton in the seed has been completed and verified. The extent of the practice, an indication of the losses so caused, and other pertinent data are set forth in Department Bulletin 375: Disadvantages of Selling Cotton in the Seed. A more popular form of the same material also will be issued.

All the work on the project of cotton handling and marketing is under the supervision of Mr. Fred Taylor.

COTTON WAREHOUSE INVESTIGATIONS.

The cotton warehouse investigations are under the direction of Mr. R. L. Nixon.

CONTINUATION OF REPORTED WORK.

The survey of facilities available for the storage of cotton was extended throughout the cotton belt, and information showing location, name, capacity, construction, cost, insurance rate on stored cotton, charges for storage, whether loans can be secured on stored cotton, and interest rates, has been tabulated covering every cotton warehouse, mill, and compress that has reported. Outline maps have been prepared showing the cotton production as compared with the storage facilities by the counties and States of the cotton belt, location of warehouses, compresses, etc., as far as the data have been obtained.

Intensive studies of many large warehouses have been made and the study of warehouse laws and legislation has been continued. Information thus gained has been useful not only in devising the system of accounts for cotton warehouses already mentioned, but has proven valuable in connection with the United States warehouse act and the plans for its administration.

WORK RELATING TO WAREHOUSE RECEIPTS.

Demonstrations were made at Little Rock, Camden, Blythesville, Forrest City, Morrillton, Pine Bluff, Hope, Newport, and El Dorado, Ark., in connection with the work on cotton marketing and handling to show the value of a certificate giving the grade of the cotton stored, especially when the warehouse receipts are offered as collateral for loans.

MARKETING COTTON SEED AND ITS PRODUCTS.

With a view to ascertaining present methods of handling, marketing, and utilizing cotton seed and its primary products, in the hope of suggesting means whereby improvements may be made and economies effected, the following lines of work have been conducted by Mr. H. T. Poe, jr.

COTTONSEED MARKETING SURVEY.

A survey was made during the time in which the bulk of the crop was marketed, which was planned to include some of the items in the marketing of the cottonseed crop which most vitally interest the

farmer; prices paid by the buyers in neighboring towns; uniformity or diversity of methods in local markets; distribution of the price that the oil mills pay; the grading and penalizing of seed when damaged; relative price paid for clean seed.

A preliminary study indicated that the territory surrounding Memphis, Tenn., was representative of cottonseed marketing conditions, and accordingly a survey was conducted in 16 primary markets where Memphis mills garner seed. A total of 1,645 seed samples was collected and the quality of each determined in order to compare their value.

From the information obtained, it appears that there is room for some economy which would greatly benefit both the grower and the crusher of cotton seed. It is believed that the general use of fair and well-defined grading rules might bring about much improvement.

STUDY OF ADAPTABILITY OF COTTONSEED OIL MILLS FOR CRUSHING PEANUTS AND SOY BEANS.

A study has been made of the business of crushing peanuts and soy beans by cottonseed oil mills. Many mills have crushed these crops this season and others are interested in the possibility. It has been found that the expense of adapting an oil mill to this work is nominal, that the crushing may be done during the season when the mill usually is idle, and that the products generally can be used for the same purposes as those produced from cotton seed. Indications are that the crushing of second and third grade kernels, consisting of screenings containing small or broken kernels, usually is profitable. The crushing of "farmers' stock" or unshelled nuts is advisable only when local economic conditions are favorable.

MARKETING LIVE STOCK, MEATS, AND ANIMAL BY-PRODUCTS.

Some of the lines of work relating to the marketing of live stock, meats, and animal by-products which were reported last year have been completed, others are being continued, and some new lines have been inaugurated. The information-file project also has been materially extended and systematized during the year. This work is under the direction of Mr. L. D. Hall.

COOPERATIVE LIVE STOCK SHIPPING ASSOCIATIONS.

Investigations which were begun during the previous fiscal year have been completed and the results published in Farmers' Bulletin 718, Cooperative Live Stock Shipping Associations. The directory of these associations has been extended to include 750 organizations. Representatives of the office stationed in Louisiana, Arkansas, and Tennessee have given special attention to the organization of such associations.

INVESTIGATIONS FOR THE COMMITTEE ON THE ECONOMICS OF THE MEAT SITUATION.

The investigations which were suggested by the committee on the economics of the meat situation have been completed, and by direction of the Secretary the report on methods and cost of marketing live stock and of slaughtering and distributing meats and animal by-products, has been prepared as Part 5 of a series of re-

ports of the office of the Secretary on the meat situation (Report 113), under the title, "Methods and Cost of Marketing Live Stock and Meats." Extensive compilations were prepared from schedules of questions on marketing live stock and meats which were sent to 10,500 live-stock correspondents and price reporters of the Bureau of Crop Estimates early in the fiscal year.

CONFERENCE AND HEARINGS RELATIVE TO MARKETING LIVE STOCK, DISTRIBUTION OF MEATS AND RELATED MATTERS.

By direction of the secretary a conference and hearing was conducted on November 15 and 16, 1915, at Chicago for the purpose of "ascertaining the essential facts pertaining to the industry with a view to bringing about more stable market conditions, more efficient methods, closer cooperation, and a better understanding among all the interests connected with the industry."

Prominent representatives of all the leading organizations of stock growers, feeders, commission men, packers, retailers, stockyard companies, traders, railroads, live-stock loan companies, banks, and other interested parties participated in this meeting. It was the first attempt ever made to bring together representatives of the various interests concerned in the live-stock and meat industry. The proceedings of the meeting were published as House Document No. 855, Sixty-fourth Congress, first session (Mar. 8, 1916). There has been a large demand for this publication, and the statements it contains have been of material assistance in connection with various phases of the work of this project.

MARKET REPORTS ON LIVE STOCK AND MEATS.

A special study of the methods, sources, accuracy, and use of market reports and variations of the prices of live stock, meats, and animal by-products at market centers, which was begun in June, 1915, was continued during a part of the past fiscal year. The results have been embodied in part in Report 113 and have been utilized also in connection with the work of other subprojects and as a partial basis for the separate project, market reports on live stock and meats, which is now being organized.

STUDY OF CENTRALIZED LIVE-STOCK MARKETS.

The study of centralized live-stock markets has been continued by means of personal inquiry, using a systematic schedule of some 70 items pertaining to the facilities, organization, and service rendered by these markets, with a view to publishing the data for the information of stockmen and others who are dependent upon these establishments. Monthly reports of live-stock receipts and shipments are now being furnished this office from 58 public stockyards, and improved methods of reporting such figures have been adopted by several of the markets at our suggestion. Especial attention has been given to the segregation of data on stockers and feeders shipped from the markets to the country, and 26 stockyards companies are now furnishing this office separate reports on stocker and feeder shipments.

THE SHIPMENT OF LIVE STOCK TO CENTRALIZED MARKETS.

A preliminary study of various phases of the shipment of live stock to centralized markets has been conducted by means of schedules sent to correspondents of the Bureau of Crop Estimates. The information obtained has been embodied in part in Report 113. Data from various other sources have been collected and arrangements have been made for cooperation with the Animal Husbandry Division and the Office of Farm Management of this department for the collection of data on actual shipments of cattle and hogs, including cost of driving and hauling to shipping points, methods and costs of bedding and loading cars, loss, damage, and shrinkage in transit.

STUDY OF MUNICIPAL ABATTOIRS.

In continuation of previous investigations, 5 municipally owned abattoirs and 8 cities which have centralized slaughtering plants privately owned, with municipal inspection and control, have been visited for the purpose of studying the possibilities and limitations of public abattoirs in their relation to local live-stock marketing conditions.

STUDY OF COOPERATIVE MEAT-PACKING COMPANIES.

A press bulletin on the subject of cooperative meat-packing companies was issued in July, 1915, based on field investigations conducted during the latter part of the previous fiscal year. This bulletin placed special emphasis on the precautions which are essential to the success of an undertaking of this kind and resulted in the modification of plans and the abandonment of unwarranted organizations in a number of communities where cooperative packing movements were contemplated. Numerous inquiries for information on this subject have indicated a marked interest in the subject and the investigations have been continued with a view to issuing a more complete publication. Six communities in which plants are being promoted have been visited and surveys made of local conditions pertaining to the feasibility of the enterprises. The representative of this office stationed in Louisiana rendered specific assistance in this matter to one community, and cooperation has been arranged with the director of extension in South Carolina in order to determine the possibilities of cooperative packing enterprises at certain cities in that State.

SURVEY OF WHOLESALE SLAUGHTERING AND DISTRIBUTION OF MEATS.

A survey of the wholesale slaughtering and meat-packing industry has been begun with special reference to the location, organization, sources of supply and demand, methods of operation, and distribution. A systematic study of wholesale slaughtering and meat-packing establishments in the North Atlantic States has been completed, and the work is being extended to include the great meat-packing centers of the Middle West.

COMMERCIAL MOVEMENTS OF LIVE STOCK AND MEATS.

A study of the location of the principal feeding districts and grazing sections has been begun as a basis for future investigations relative to the shipments of live stock to and from these areas. The in-

formation thus gained will be of special value in connection with the new project, market reports on live stock and meats.

STUDY OF STATE LIVE-STOCK MARKETING PROBLEMS AND CONDITIONS.

The entire time of the field assistant of the office who is stationed in Louisiana has been devoted to problems pertaining to the marketing of live stock and meats. A comprehensive survey of the live-stock marketing facilities and conditions of the State has been made; 52 parishes have been visited, and personal assistance in marketing live stock, wool, meats, and other products rendered to a large number of farmers; many talks on various phases of live-stock and meat marketing have been delivered in different parts of the State. One cooperative shipping association has been organized and preliminary arrangements for such organizations have been made in four other parishes. The owners of two ice plants have purchased dressed hogs from farmers, cured the meat at their plants, and disposed of the cured products locally, and four other plants have been induced to carry on the work during the next winter. Investigations have been conducted relative to the meat supply of various cities, the distribution of meats, and the establishment of proposed public abattoirs. Important conferences pertaining to the reorganization of the centralized live stock market and slaughtering facilities at New Orleans were participated in by invitation of officials of the New Orleans Chamber of Commerce.

The agent representing the Office of Markets and Rural Organization in Arkansas has devoted special attention to the purchase and handling of dressed hogs at local ice plants. Approximately 50 plants have been visited for the purpose of explaining the advantages of purchasing dressed hogs from farmers and giving instructions on the curing and marketing of pork products. As a result of this work eight ice plants in the State purchased 3,258 hogs from farmers during the past winter; at three other plants 310 hogs were chilled for farmers; three plants advertised for dressed hogs, but received none, and three others have improved their storage facilities so as to engage in this business next fall. As a further result of this work in Arkansas, three plants in Mississippi have engaged in the business during the past winter and purchased and cured 730 hogs. The project also has been extended to include retail meat markets, three of which have installed cold-storage facilities to handle hogs, and others have signified their intention of doing so during the coming season.

Intensive work has also been performed by field men stationed in Tennessee and Vermont. Special attention has been given to the marketing of farm-prepared meats and to the question of marketing live stock locally, and much information of value has been secured.

Reports on live-stock marketing conditions and problems in Colorado and Wyoming were prepared from data obtained in investigations conducted during the latter part of the fiscal year 1915, and were submitted to the governor of the State in each instance.

MARKETING OF DAIRY PRODUCTS.

The investigations in the marketing of dairy products have included butter, cheese, and milk. Special attention has been given to

those phases of importance in perfecting more efficient, economical, and equitable methods of marketing. The work is under the direction of Mr. Roy C. Potts.

BUTTER MARKETING INVESTIGATIONS.

A general survey of the butter markets of the South has been completed, and a supplementary study has been made of the keeping quality of southern creamery butter in storage. As a result of these investigations, a manuscript has been prepared in cooperation with the Dairy Division of the Bureau of Animal Industry and will be published. Assistance was rendered to a number of creameries in improving their facilities and their methods of marketing butter.

Supplementing these butter-marketing investigations, other studies were made in the principal butter markets in the States of Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, Maryland, New Jersey, and New York, and the New England States. Upon completing these investigations a bulletin was prepared for publication.

MILK MARKETING INVESTIGATIONS.

Milk-marketing investigations were conducted in the following cities: Detroit and Kalamazoo, Mich.; Chicago, Ill.; Milwaukee, Wis.; Indianapolis, Ind.; Pittsburgh, Erie, and Johnstown, Pa.; New York and Poughkeepsie, N. Y.; Boston, Springfield, and Worcester, Mass.; New Orleans, La.; Fort Worth, Tex.; Oklahoma City, Okla.; and Kansas City, Columbia, and St. Louis, Mo. The survey at Detroit, Mich., included the whole business of supplying the city with milk and was made in cooperation with the Dairy Division of the Bureau of Animal Industry. In cooperation with the New York State College of Agriculture, an investigation was made of the marketing of milk by producers in that State.

CHEESE MARKETING INVESTIGATIONS.

Investigations of the marketing of cheese have been conducted in a number of consuming markets and cheese-producing sections. These investigations are to be continued, and it is planned to include the whole subject of cheese marketing from factory to consumer.

COOPERATIVE INVESTIGATIONS.

Under an agreement with the commissioner of agriculture of Vermont, with the joint employment of an investigator, surveys have been made of the marketing of Vermont's dairy products, with the object in view of effecting more efficient and equitable methods of marketing.

SUPPLEMENTARY DAIRY INVESTIGATIONS.

A preliminary study of the activities of a large number of cooperative dairy marketing organizations has been made, and the information obtained indicates that many have been successful in improving their marketing conditions and marketing methods. Among other special studies may be mentioned those regarding the shrinkage in butter from creamery to market and the factors affecting it; and the facilities, methods, and costs of transporting milk into cities from areas of supply.

GRAIN, SEEDS, AND HAY MARKETING INVESTIGATIONS.

Studies and investigations relating to grain, seeds, and hay marketing were undertaken as a separate project shortly before the beginning of the fiscal year 1916. The purpose of the work, which is under the direction of Mr. George Livingston, is to make a careful and detailed economic study of grain, hay, and seed marketing at producing centers and large central markets, together with their sale to the consuming public, in order to obtain information useful to the various agencies engaged in marketing and distributing these products, and for the purpose of offering constructive suggestions for the improvement of the service.

STUDY OF MARKETING GRAIN AT COUNTRY POINTS.

A general survey of the methods of marketing grain at country points in the surplus-grain States of the Middle West was carried on during the summer and fall of 1915. Much useful information was obtained relating to the cost of marketing, methods of purchase and sale, place of sale, prices and price quotations, storing grain, contracting with farmers for future delivery, handling grain for farmers, hazards of the country elevator business, and related subjects. It is planned to make this information available to the public.

STUDY OF TERMINAL-MARKET PRACTICE.

The terminal-market studies which were undertaken during the fall of 1915 consisted of a study of the factors influencing the extent of the contributing territory and the outlet for each market; a comparative study of the organization of chambers of commerce and boards of trade, together with the uniformity and equity of trade rules; terminal charges, methods of weighing, inspecting, and storing grain; charges, functions, and services rendered by brokers, commission merchants, track buyers, jobbers, warehousemen, and other agencies engaged in terminal marketing; prices and causes of their fluctuation; future transactions, their relation to hedging and speculation; private-wire houses and special crop reports; market quotations and other phases of terminal grain marketing.

STUDY OF MARKETING GRAIN AND HAY IN THE EAST AND SOUTH.

An investigation of the retail distribution of grain, grain products, and hay was begun in the early part of 1916. A large amount of information was gathered relative to the functions of exchanges, brokers, jobbers, and retailers; cost of distribution, difference between wholesale and retail price, as well as variation in cash and credit quotations and door and delivery price; general and special methods of retail distribution, together with other information relative to the subject.

ISSUANCE OF SOUTHERN MARKET REPORTS.

The natural outlet for the surplus oats of the Southwest is in the Southeast. In order to aid the growers of the South in the profitable distribution of their crop during the early movement, a series of oat-market reports was issued during June and July, 1916. Informa-

tion was received by wire at the Office of Markets and Rural Organization relative to price quotations and demand, which was compiled and distributed among the growers and dealers in the producing territory in cooperation with the Office of Extension Work in the South. The oat crops of Oklahoma and Texas were marketed at a better price than ever before, when compared with prices obtained for oats in other sections.

STUDY OF EXPORT GRAIN.

In order to ascertain the quality and condition of grain entering into export trade and the accuracy and completeness of the inspection service upon which grade certificates were based, the important export markets have been visited and studied. The subject was of special importance and interest because of the unsatisfactory condition of grain arriving in foreign ports and the resulting commercial difficulties.

MINOR INVESTIGATIONS.

In order to assist the Southern States in marketing the corn crop, which presented unusual and difficult problems, a leaflet relating to methods of preparing grain for market and the utilization of local facilities for storage and distribution was prepared for the Office of Extension Work in the South for distribution among the State and county agents and others. The rapid increase in the production of grain sorghums has brought forth the problem of finding new markets for them. A beginning has been made on a study of this problem. In order to obtain information regarding the method of warehousing and storing grain at large central markets and at country elevators special study of the subject was made at several of the large markets and representative country elevators.

Information resulting from the investigations of grain, seed, and hay marketing will be made available for use as rapidly as practicable. As supplementing the information and material supplied by the grain standardization investigations of the Bureau of Plant Industry, the results of the studies of this office have already been of considerable value in connection with the framing of rules and regulations under the United States grain standards act and in planning for its administration.

FOREIGN MARKETS INVESTIGATIONS.

Plans have been developed and formulated for the investigation of foreign markets for American farm products under normal conditions and for the assistance so far as possible in the development of the export trade in these products. It is planned to continue investigation of the marketing of the farm products of the United States by studying the disposition of and the demand for that portion which is sold or consumed abroad, with a view to the development of our export trade in agricultural products.

The problems first to be taken up will be those most pressing and those that give the best promise of early results. Europe, South America, and China will receive special attention. Trade conditions in the markets are to be studied carefully, while the factors affecting foreign marketing of American grain are to receive special consid-

eration. The marketing of fruits and vegetables, especially of the less perishable varieties, is to be carefully studied with a view to improving methods and developing the foreign demand.

A representative of the Office of Markets and Rural Organization was sent to Europe late in June for a period of several months for the purpose of inaugurating this work in a preliminary way. He is traveling in part with the Assistant Chief of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and has visited points in England, France, Italy, and Switzerland, and will visit other European countries before his return. A study is being made of actual and normal conditions in these foreign markets as far as they relate to American farm products, and their customs, preferences, and consuming capacities. The representative is conferring with the consular offices of the State Department, with the commercial attachés of the Department of Commerce, and the import agents and dealers engaged in handling and marketing American farm products.

As the work develops other phases of the problem will be investigated. Effort will be made to coordinate the activities of foreign representatives of American organizations, both public and private, in investigating and reporting on foreign markets for the surplus farm products of the United States.

MISCELLANEOUS MARKETING ACTIVITIES.

An experiment in stimulating demand and distribution was conducted during the peach season of the fiscal year. During the months of August and September, 1915, about 33,000 circular letters were sent out to retailers in 46 cities of 13 northern and eastern States urging them to move peaches rapidly and under the modern methods outlined. Personal efforts were given to the work in New York City and Pittsburgh. Local efforts to stimulate demand and consumption were encouraged in such ways as were practicable. Inquiries were made in 30 or 40 towns and cities in central and eastern Pennsylvania and in southeastern Ohio to discover if there are markets large enough to use carloads of peaches during the height of the season that usually do not get them. It was found that almost universally these markets of from 2,000 population up are thoroughly worked by the jobbers from the larger cities or have local jobbers or both, and that these firms ship carloads of peaches into these markets whenever possible. In other words, these markets are not neglected.

Considerable cooperative work with various States has been conducted during the year both regarding problems in marketing and distribution and in rural organization. In many instances the problems studied were local, but in other cases observations and results were capable of general application.

As a preliminary to work in aiding various States to coordinate State and Federal marketing activities, to be inaugurated as a separate project in the fiscal year 1917, a survey of State marketing activities was made by means of a series of questionnaires, the results of which were issued as Markets Document No. 3, Results of a Survey of State Marketing Activities Throughout the United States.

RURAL ORGANIZATION INVESTIGATIONS.

The various lines of work relating to rural organization which were reported last year have been continued and certain new lines begun. Mr. C. W. Thompson directs these investigations.

RURAL CREDIT, INSURANCE, AND COMMUNICATION.

The work of rural credit, farmers' mutual insurance, and rural communication has been associated since the beginning of the investigations.

RURAL CREDIT.

The investigation of the costs and sources of farm loans (both farm-mortgage loans and loans on personal and collateral security) has been continued, and tables showing averages for interest and commission or extra charges, by States and for districts within the States, have been compiled. The relative importance of the different rates in each State is shown, together with the proportion of the farm-mortgage business done without commission, with advance commission, and with installment commission. From statements submitted by 220 companies, representing more than 99 per cent of the total assets of life insurance companies in the country, figures have been compiled showing, by States, the amount of farm mortgages held by such companies. Estimates have been made, by States, for the total farm-mortgage debt outstanding, and a table has been prepared showing the proportion of this total amount in each State held by life insurance companies and by banks. A number of charts, representing in graphic form the most important of the items here mentioned, have been prepared, and the major part of the information has been included in two publications, Department Bulletin 384, *Costs and Sources of Farm Mortgage Loans in the United States*, and Department Bulletin 409, *Factors Affecting Interest Rates and Other Charges on Short Time Farm Loans*. Another publication on *Amortization Methods for Farm Mortgage Loans*, Circular 60, Office of the Secretary, has been issued.

An investigation has been made to determine the extent to which farmers in the Southern States obtained credit from merchants, either under the advancing system or otherwise. The work of tabulating the information received on this subject is nearly completed.

A digest of existing State laws for the organization of credit unions is nearly completed. Suggestions have been given to various States in matters bearing on legislation for cooperative credit associations, and articles of agreement have been prepared for farmers' credit exchanges.

INSURANCE.

Additional information concerning special problems confronting farmers' mutual fire, windstorm, live-stock, and hail insurance companies has been gathered, and the divergent business methods employed by these companies have been studied. Special questionnaires have been prepared for each of the three classes of companies last mentioned, the total number of which is 124, and replies have been received from about one-half of them. Information concerning the

plan of organization and the most practical methods of operation of farmers' mutual insurance companies has been disseminated in many ways.

COMMUNICATION.

A preliminary survey of farmers' telephone companies has been completed. An intensive study has been made of the forms of organization, methods of financing, and types of telephone systems used by a considerable number of companies in West Virginia, Maryland, Pennsylvania, and New York. Assistance has been given to a number of farmers who have applied for information regarding the organization of telephone companies.

RURAL SOCIAL AND EDUCATIONAL ACTIVITIES.

RURAL SURVEYS.

The two intensive surveys reported as in progress last year have been completed. The survey of Orange County, N. C., was made in cooperation with the University of North Carolina and other local organizations. This work included farm-home and organization surveys and was carried on by field workers who visited the homes in the different communities. A similar survey has been made in Albemarle County, Va. The material gathered in these two counties has been tabulated and detailed reports are in preparation.

A collection of published surveys, especially rural surveys, has been brought together, and a study has been made of the manner in which these surveys have been conducted, the form of the questionnaire used, and the conclusions reached.

STUDY OF EXISTING ORGANIZATIONS.

Material in regard to the social and educational activities of various national farmers' organizations has been brought together. A preliminary study has been made of their methods of organization and of conducting meetings and their efficiency in meeting the social and economic needs of the rural people in the States where they are located. An intensive study of the social activities of the Grange in Ohio made by this office, in cooperation with the officers of the Ohio State Grange and the agricultural college of the Ohio State University is nearly completed.

Mailing lists of over 10,000 women's organizations in towns of less than 2,500 inhabitants have been compiled. An intensive study of women's organizations in Tennessee has been conducted by the questionnaire method and the resulting data have been tabulated. By extensive field trips, by personal investigation of local clubs, and from published reports, the work of women's rural organization is being carefully studied.

As a result of some of the investigations of rural organizations articles of agreement and by-laws for local rural community clubs have been prepared. Suggested programs have been supplied to local community clubs in Alabama, where active field assistance has been given in the organization of such community clubs. Plans have been developed for the extension of rural community program work into Tennessee and Wisconsin.

An article on "How the Department of Agriculture Promotes Organization in Rural Life" was published in the 1915 Yearbook and has been issued as Yearbook Separate 675.

INVESTIGATION AND DEMONSTRATION OF COTTON STANDARDS AND COTTON TESTING.

The investigation and demonstration of the official cotton standards of the United States and the work in cotton testing under the direction of Mr. Fred Taylor has comprised the continuation of some of the work of last year, together with several new lines.

INVESTIGATION AND DEMONSTRATION OF COTTON STANDARDS.

Demonstrations of the use of the official cotton standards of the United States were continued in Edgecombe, Wayne, Wilson, and Mecklenburg Counties, N. C.; at Little Rock, Scott, and Camden, Ark.; Gadsden, Ala.; Sweetwater, Tex.; and in the Imperial Valley of California. The object was to demonstrate and promote the more general use of the standards and to show the farmer the benefits resulting from a more general use of a recognized standard.

In cooperation with the States Relations Service, and to further this work, 125 copies of the 9 grades of the official cotton standards representing white cotton have been prepared for shipment to county demonstration agents.

EFFECT OF COMPRESSION ON GRADE.

At New Orleans, La.; Gadsden, Ala.; Talboro, N. C.; and Little Rock and Conway, Ark., an investigation was conducted for the purpose of determining the effect of compression on the grade of cotton. It was found that in from 24 to 48 hours after being taken from compressed bales and exposed to the atmosphere, samples regained their original uncompressed appearance, and that the grade was not affected by compression.

ESTABLISHMENT AND PROMULGATION OF STANDARDS FOR TINGED AND STAINED AMERICAN COTTON.

During the fall of 1915 the work of determining suitable standards for tinged and stained American cotton was completed, and on January 28, 1916, the Secretary of Agriculture established and promulgated the following standards for tinged and stained American cotton:

- Yellow Tinged cotton of the grade of Good Middling.
- Yellow Tinged cotton of the grade of Strict Middling.
- Yellow Tinged cotton of the grade of Middling.
- Yellow Tinged cotton of the grade of Strict Low Middling.
- Yellow Tinged cotton of the grade of Low Middling.
- Yellow Stained cotton of the grade of Good Middling.
- Yellow Stained cotton of the grade of Strict Middling.
- Yellow Stained cotton of the grade of Middling.
- Blue Stained cotton of the grade of Good Middling.
- Blue Stained cotton of the grade of Strict Middling.
- Blue Stained cotton of the grade of Middling.

STUDIES TOWARD FURTHER STANDARDIZATION.

The tentative standards previously worked out for the Arizona-Egyptian cotton have continued in trial use, and further studies have been made regarding their practicability. These standards may be promulgated officially if it is found that they are representative of the crop produced during several seasons.

Samples of cotton from all of the representative long-staple sections of the cotton belt have been collected; also other types which represent the ideas of buyers, brokers, and cotton mills. These samples are being examined with a view to developing standards for length of fiber.

Samples of Sea Island cotton have been secured from all of the representative markets in order to study the practicability of standardizing this valuable crop. Samples showing the various standard types now being used by the trade have also been secured for reference. Under provisions of the United States cotton futures act further studies have been made of cotton representing perished and immature staple, and of gin-cut cotton, with a view to formulating types representative of these qualities. Samples representing this class of cotton have been obtained in connection with the standardization of tinged, stained, and blue cotton. In addition a large number of spot markets, and the future exchanges have furnished the office with the types in use in their markets.

COTTON TESTING.

SPINNING TESTS ON COTTON STANDARDS.

Spinning tests have been conducted at a commercial manufacturing house at Fall River, Mass., on 109 bales of cotton, representing the following five grades of the official cotton standards: Middling Fair, Good Middling, Middling, Low Middling, and Good Ordinary. The cotton was separated into two lots: (1) Cotton produced east of the Mississippi and (2) cotton produced west of the Mississippi. The tests were made in order to determine the comparative values of the cotton of these grades by ascertaining the percentage of waste and the tensile strength of the yarn and woven fabrics.

The following table gives briefly a summary of the total percentages of waste based upon the original net amount of cotton fed into the opener:

	Middling Fair.	Good Middling.	Middling.	Low Middling.	Good Ordinary.
Eastern cotton.....	8.63	8.75	10.66	12.23	15.64
Western cotton.....	8.22	9.35	11.47	13.37	16.89

The following table gives briefly a summary of the tensile strength in pounds per skein of 22's warp yarn; 4.75 twist factor:

	Middling Fair.	Good Middling.	Middling.	Low Middling.	Good Ordinary.
Eastern cotton.....	74.1	75.8	70.5	71.0	66.4
Western cotton.....	82.4	79.0	79.1	69.7	75.1

Approximately 50 pounds of cotton from each bale were sent to the North Carolina College of Agriculture and Mechanic Arts (textile department) and a check test was conducted by the office against the results found at the commercial mills. Cotton originating from the different zones of the cotton belt, namely, Piedmont, Coastal Plains, Eastern Gulf, Western Gulf, and red and black prairie lands of Oklahoma and Texas was tested separately.

The check tests indicated that the percentage of waste taken out in the manufacturing processes of the cotton representing the respective zones were within 1 per cent of each other. All of the cotton represented commercial 15/16 staple.

The check tests indicated also that the cotton grown in the Western Gulf and in the red and black prairie lands of Oklahoma and Texas produced a stronger but somewhat harsher yarn than the cotton of the Piedmont, Coastal Plains, or Eastern Gulf.

Tests have been conducted in the laboratory of the Office of Markets and Rural Organization on samples of yarn made from the respective grades of cotton. Moisture tests also are being made on samples of cotton that were secured during the various processes. Samples of the cloth, bleached and unbleached, are being tested by the United States Bureau of Standards in order to determine the comparative tensile strength of the different materials.

BLEACHING TESTS ON COTTON STANDARDS.

Cloth samples representing over 100 different combinations of warp and filling, made from the 5 eastern and 5 western grades of cotton, were bleached at two commercial bleacheries in order to determine the comparative bleaching properties.

Laboratory tests are now being made at the New Bedford Textile School as a check against the work done at the commercial establishments. The percentage of loss due to the bleaching processes, also the comparative tensile strength of the material before and after bleaching, is to be determined.

OTHER TESTS.

At the request of the Federal Horticultural Board tests were made of foreign-grown cotton which had been fumigated with hydrocyanic-acid gas as a preventive against the introduction of the pink boll worm. It was shown that fumigation with hydrocyanic-acid gas does not injure the fibers of the cotton for spinning purposes, and a description and the results of the tests have been set forth in Department Bulletin 366, *Manufacturing Tests of Cotton Fumigated with Hydrocyanic-acid Gas*.

Tests of the five tentative grades of Arizona-Egyptian cotton have been made in comparison with Georgia Sea Island cotton and Sakellaridis Egyptian cottons of the same relative grade and length of staple. The results indicate that the Arizona-Egyptian cotton is less wasteful and substantially equal in other respects to the other cottons used in these tests. Descriptions of the tests and the results have been published as Department Bulletin 359, *Comparative Spinning Tests of the Different Grades of Arizona-Egyptian with Sea Island and Sakellaridis Egyptian Cottons*.

ENFORCEMENT OF THE UNITED STATES COTTON FUTURES ACT.

The enforcement of the United States cotton futures act has continued to be an important part of the work of the office. The chief of the office exercises direct supervision over all of the enforcement, but Mr. William R. Meadows has been the leader of the projects which have been inaugurated for the effective execution of this work. Five Service and Regulatory Announcements have been issued during the year, two of them being of general interest. Information has been furnished to Congress, on request, in connection with the law, which was reenacted, with slight changes, since the close of the fiscal year.

At the request of those who promoted the recent organization of the cotton exchange at Rotterdam, and in cooperation with the office of the solicitor, a complete set of future and spot rules for trading in cotton has been drawn for its consideration and possible use. The cotton exchange at Rotterdam has adopted the official cotton standards of the United States for white cotton.

INVESTIGATION OF FUTURE AND SPOT MARKETS FOR COTTON.

The work relating to market quotations has continued along the lines described in our previous report. Further work is as follows:

INVESTIGATION OF FUTURE EXCHANGES.

Careful investigations have been made of the future exchanges at New York and New Orleans, both of which have adopted a form of future contract which conforms to the specifications of section 5 of the cotton futures act. All changes in the rules of future exchanges are critically examined and compared with the terms of the act. Suggestions as to changes have been made from time to time wherever a conflict seemed apparent between any rule and the act.

The policy of maintaining a representative of the office at New Orleans in order to keep in touch with the application of commercial differences on the cotton exchange in that city has been continued. The quotations of the leading cotton future exchanges have been studied carefully and charts have been compiled and published in Service and Regulatory Announcements No. 9 which show the fluctuation in prices on these exchanges. The charts show the efficiency of the act in accomplishing the ends for which it was designed, notably the fact that futures and spot prices have maintained a fair parity since the act became effective.

INVESTIGATION AND DESIGNATION OF SPOT MARKETS.

Investigations of spot markets have been made during the last fiscal year by frequent visits of members of this project to cities of the United States where cotton customarily is bought and sold in large quantities. To the cities that had already been designated as bona fide spot markets under the cotton futures act, Fort Worth, Tex., was added during this year. The cotton exchanges at Atlanta, Ga., and San Antonio, Tex., have been cooperating with the office, and Atlanta has been designated as a bona fide spot market since the close of the fiscal year.

DETERMINATION OF DISPUTES.

Under the seventh subdivision of section 5 of the United States cotton futures act, the Secretary of Agriculture is authorized to determine disputes which may arise between the parties to a future contract made in conformity to the act, as to the grade, quality, and length of staple of any cotton tendered in the fulfillment of the obligation. Under the direction of the chief of the office and the project leader the work is performed largely by expert cotton classers termed "examiners."

An examination of the daily reports of the exchanges shows that the total number of bales delivered on future contract at New York from July 1, 1915, to June 30, 1916, was 135,300, of which 26,717, or 19.7 per cent, was involved in the disputes referred to the department for determination. Of this number, one dispute, involving 5 bales, was dismissed, leaving a total of 26,712 bales passed upon by the examiners.

According to published reports, the number of bales delivered on contract at New Orleans was 102,900, but no dispute in reference to such cotton was referred to the department.

The following table presents in convenient form, by months, the number of original disputes received and the number of bales involved therein:

Month dispute received.	Number of original disputes.	Number of bales in original disputes.	Number of replacement disputes.	Number of bales in replacement disputes.
1915: July.....	119	12,023	21	276
August.....	28	2,062	26	278
September.....	5	315	1	17
October.....	69	3,622	3	17
November.....	27	2,060	1	2
December.....	35	2,145	3	6
1916: January.....	33	1,691		
February.....				
March.....	9	215		
April.....	4	214		
May.....	6	421		
June.....	13	1,346	1	7
Total.....	* 348	26,114	56	603

The total sum collected as costs for the determination of disputes heard during the fiscal year was \$9,322.55, of which \$7,182.91 was assessed against the complainants and \$2,139.64 against the respondents. All of this fund was covered into the Treasury of the United States, in accordance with the provisions of the cotton-futures act.

Aside from the actual determination of disputes, the examiners have made a careful study of all the facts related to the handling of disputes and certain deductions therefrom. This information was published in Service and Regulatory Announcements No. 8.

PREPARATION AND DISTRIBUTION OF PRACTICAL FORMS OF THE OFFICIAL COTTON STANDARDS OF THE UNITED STATES.

The actual work of preparing and distributing practical forms of the official cotton standards of the United States is under the direction of Mr. Fred Taylor.

PREPARATION AND SALE.

The official cotton standards for grade for white American cotton were established and promulgated on December 15, 1914, under the authority of the United States cotton futures act, and the work involved in the preparation and distribution of practical forms of these standards has been in progress since that date, 248 full sets having been shipped during the past year, making 633, the total number of full sets shipped to the various branches of the trade up to the 1st of July. Nineteen of these full sets were sent to foreign countries. Seventy-eight fractional sets have also been supplied to cotton mills and those who deal in only a limited number of the grades. On July 1, 1916, 100 sets were ready for use in filling orders for the coming season.

The purchases of cotton for standardization work are distributed geographically throughout the cotton belt. It is necessary to purchase large quantities of cotton for this work, owing to the impossibility of ascertaining the extent to which the contents of a bale of cotton can be used for standardization purposes before it actually is opened and put into use, especially in the preparation of the standards for color. The proceeds from the sale of cotton which was not usable were turned into the Treasury as miscellaneous receipts. During the fiscal year ended June 30, 1916, \$23,087.69 was covered into the Treasury as a result of sales of rejected cotton.

ADOPTION OF THE OFFICIAL COTTON STANDARDS.

During the past fiscal year a number of additional domestic markets have adopted the official cotton standards as the basis of their transactions. The following list contains the future and spot markets which have adopted the standards up to July 1, 1916:

New York Cotton Exchange.	Waco Cotton Exchange.
New Orleans Cotton Exchange.	Houston Cotton Exchange.
Montgomery Cotton Exchange.	Dallas Cotton Exchange.
Augusta Cotton Exchange.	Paris Cotton Exchange.
Selma Cotton Exchange.	San Antonio Cotton Exchange.
Little Rock Cotton Exchange.	Norfolk and Portsmouth Cotton Exchange.
Mobile Cotton Exchange.	Cotton Manufacturers' Association of North Carolina.
Savannah Cotton Exchange.	Cotton Manufacturers' Association of South Carolina.
New England Cotton Buyers' Association, Boston.	Fort Worth Grain and Cotton Exchange.
Fall River Cotton Buyers' Association.	Clarksdale (Miss.) Cotton Exchange.
St. Louis Cotton Exchange.	Yazoo City Cotton Exchange.
Vicksburg Cotton Exchange.	Greenwood Cotton Exchange.
Oklahoma State Cotton Exchange.	Greenville Cotton Exchange.
Charleston Cotton Exchange.	Atlanta Commercial Exchange.
Memphis Cotton Exchange.	
Galveston Cotton Exchange.	
Texas Cotton Buyers' Association.	

Total distribution of practical forms of the official cotton standards by States to and including June 30, 1916.

State.	Full.	Fractional.	Colored.	State.	Full	Fractional.	Colored.
Alabama.....	33	3	2	Minnesota.....	1		
Arizona.....	1			Mississippi.....	29	1	
Arkansas.....	35	1	1	Missouri.....	5	1	
California.....	7			New Hampshire.....	7		
Connecticut.....	1	4		New Jersey.....	1		
District of Columbia.....	3		1	New York.....	44	7	6
Florida.....	1			North Carolina.....	37	7	
Georgia.....	84	4	5	Oklahoma.....	14		
Illinois.....	1	1		Pennsylvania.....	4	2	1
Indiana.....	2			Rhode Island.....	8	10	
Kentucky.....	1	1		South Carolina.....	60	4	2
Louisiana.....	31	1	1	Tennessee.....	23	6	2
Maine.....	5	1		Texas.....	101	1	4
Maryland.....	1	1		Vermont.....	1		
Massachusetts.....	57	21	5	Virginia.....	4		1
Foreign.....	19	1		Total.....	633	78	31

During the fiscal year the amount of \$4,875.80 was returned to the Treasury as the result of the sale of practical forms of the official cotton standards.

INSPECTION OF SETS.

In accordance with the rules and regulations governing the administration of the cotton futures act, practical forms of the official cotton standards now in use have been inspected by a duly authorized inspector. The certifications as to grade were canceled in such of the grade boxes as were no longer in accord with the original standards. The owners were advised to return to Washington for correction such boxes of the standards as were found to be inaccurate. On July 1, 1916, 288 sets had been inspected and 136 boxes, or about 5 per cent, had been returned to the department for revision. The color in the standards, especially in the lower grades, bleaches out more or less, which makes occasional inspection necessary.

COMPARISON BETWEEN ORIGINAL AND VACUUM SET.

In order to check by comparison the accuracy and uniformity of the present practical forms of the standards, vacuum set No. 1 of the standards for white cotton stored under conditions described in Service and Regulatory Announcements No. 6, was opened January 19, 1916, and a comparison was made with the original set of the official cotton standards of the United States now stored in a vault at the Treasury Department. The sets compared favorably, showing the original set of the standards to be in a satisfactory condition.

PREPARATION AND DISTRIBUTION OF PRACTICAL FORMS OF STANDARDS FOR COLOR.

On the promulgation of the official cotton standards for tinged and stained cotton the office prepared a sufficient number of copies of the practical forms for color and furnished them to the future exchanges and to the bona fide spot markets for use in the determination of commercial differences.

Ten copies of the standards, representing tinges and stains, have been prepared and stored in vacuum tubes for future reference.

It is believed, from tests made with this character of cotton, that the color of the standard will be accurately maintained by such storage. Because of the transitory nature of the color in the character of cotton used for color standards, inspection and replacement of the practical forms which are in use will be necessary from time to time.

Cotton has been purchased for use in preparation of additional copies of standards for color in order that the general distribution may be begun in time for the next crop. A complete set of the standards for color is sold for \$25, or \$2.50 for each box. The use of these standards will provide a more satisfactory basis for spot quotations than is otherwise possible. Uniformity in the acceptance and use of the standards in the designated spot markets is essential to the satisfactory determination of commercial differences for the settlement of future contracts. The official standards for color replace the tentative guides for color issued on February 18, 1915.

TOTAL AMOUNT COVERED INTO THE TREASURY.

Since the work relating to the enforcement of the cotton futures act began the following amounts have been transmitted to the United States Treasury: \$12,307 as the result of sales of the practical forms of the official cotton standards; \$26,885.66 as a result of the sales of rejected cotton; \$24,783.25 assessed as charges for the hearing of disputes; making a total of \$63,975.91 which has been covered into the United States Treasury as a result of this work.

DEPARTMENTAL COOPERATION.

In conclusion, it is desired to acknowledge, as in previous years, the cooperation of many of the other bureaus and offices of this department as well as that of certain other departments. The nature of the work of the Office of Markets and Rural Organization is such as to make this cooperation necessary. There should be mentioned especially the Bureau of Animal Industry and the Dairy Division of that bureau, the Bureau of Plant Industry, the Bureau of Crop Estimates, the Bureau of Chemistry, the States Relations Service, the Federal Horticultural Board, and the Office of the Solicitor, whose legal services and advice have been indispensable.

REPORT OF THE CHIEF OF THE OFFICE OF FARM MANAGEMENT.

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
OFFICE OF FARM MANAGEMENT,
Washington, D. C., September 15, 1916.

SIR: I am submitting herewith the annual report of the Office of Farm Management covering the work done and results accomplished during the year just closed.

Respectfully,

W. J. SPILLMAN, *Chief.*

Hon. D. F. HOUSTON,
Secretary of Agriculture.

The principal problems under investigation by this office, with the more important results obtained during the past year, are as follows:

Because of the recent rapid increase of tenant farming in those sections where land values have been increasing markedly the proper form of contract between landlord and tenant has become a problem of general interest. The Office of Farm Management has had this problem under investigation during the past year, and now has the data necessary for a publication on this subject for two important agricultural regions.

In connection with the preparation of an atlas of American agriculture, the office is also tabulating the facts concerning the percentage of tenantry in all sections of the country, and the changes in this percentage in recent years.

The Office of Farm Management is studying the conditions under which the production of beef cattle and sheep can be made profitable. The results of this study indicate that under present conditions the production of baby beef on corn-belt farms gives fairly satisfactory economic results, while even the production of feeders can be made profitable with good management.

These investigations also indicate that, in some localities at least, a small flock of sheep may serve to increase the net profits of the farm even where the usual cost-accounting methods would indicate a loss on the enterprise.

In connection with the dairy industry, the problem of suitable labor is ever present. This makes the place of the milking machine in the organization of the dairy farm a major problem. During the past year an investigation has been made of the effect of the milking machine on the organization of farm labor, and a manuscript on this subject has been prepared for publication.

Special attention has been given to the production of milk for the city trade in connection with farm-management surveys during the past year. Records have also been kept of costs on a number of dairy farms.

Studies have been continued on the cost of growing a dairy cow to maturity.

Apparently the hog, under suitable conditions, is the most profitable animal on the American farm. The conditions under which swine husbandry should occupy a major position, as well as those under which it should occupy a minor position in the enterprises of the farm have received attention during the past year in connection with our farm-management surveys.

Poultry is perhaps more universally found as a productive enterprise on American farms than any other class of live stock. The proper magnitude of the poultry enterprise on farms of different size and type and in different regions has received particular attention in the surveys. It appears that within certain limits a flock of farm poultry adds very materially, not only to the standard of living on the farm, but to the profits made by the farmer. This seems to be true even where the usual cost-accounting methods indicate that the poultry are kept at a loss. Department Bulletin 341 gives the most important results of this study thus far published.

The price of feed for farm work horses has made a knowledge of the cost of keeping farm horses of great importance. The subject has received considerable attention in the Office of Farm Management during the past year. Cost-accounting studies in three districts in the States of New York, Illinois, and Ohio, begun some years ago, are still in progress. These studies include data on the amount, kind, and value of feed consumed, and other items affecting the cost of maintaining horses. The cost of raising colts and the relation of this enterprise to the cost of horse labor on the farm are under investigation.

CROP ECONOMICS.

The economic studies on crops during the past year have been confined largely to investigations on sugar beets, apples, potatoes, hay, corn silage, cotton, and the farm wood lot.

SUGAR BEETS.—Within the past year about 350 cost-accounting records have been procured on farms where the sugar beet is an important crop. These studies have been carried on in the important sugar-beet producing districts in the States of Michigan, Colorado, and Utah. Other important districts will be studied in 1916. These schedules have been summarized and the results are being compiled for publication. Much valuable information has been secured showing the place that sugar beets occupy in the farm business, time required for the various operations needed in their production, the cost of these operations, and the cost of the various expense items necessary for the crop. These data will be useful in determining the cost at which sugar beets can be produced economically on farms in the various areas, as well as showing what part of the farm business should be devoted to the production of this crop.

APPLES.—The work on the economics of apple production has been continued during the past year with marked success. All the

large apple-growing districts in the West and the Northwest have been studied and data are available giving in detail the time required for each operation and the amount of each item entering into the cost of producing apples. In all, nearly 1,000 records have been taken on farms where the apple orchard is an important enterprise. Many of these data have been summarized and four manuscripts have been prepared for publication.

POTATOES.—Investigations on the cost of producing potatoes and the place that potato growing occupies in the farm business have been continued with a view to obtaining further results in each of the districts before publication. Over 900 cost records have been collected, compiled, and the data prepared for publication.

HAY.—The investigations on the cost of producing hay and the management of labor in haying have been continued during the past year, particularly in the Northern and West Central States. A large number of records have been obtained on farms in each of the districts where the hay crop is of primary importance. These data are being compiled for publication in bulletins and circulars.

CORN SILAGE.—Substantial progress has been made on the investigation dealing with farm practice in the production of corn silage, equipment required, cost of production, etc. Many data have also been secured on the capacity of silos, shrinkage, etc. The work has been conducted by making cost-accounting studies on a large number of farms in districts where corn silage is the important crop. Careful tests and weighings of silage have been made in cooperation with farmers.

COTTON.—The investigation on the cost of producing cotton has for its purpose the determination of farm practice, equipment required, and profitableness of the enterprise. The investigations during the past year have been largely in the form of farm-management surveys on farms where cotton growing is of primary importance. The results of these investigations are now ready for publication. Records are available for over 500 farms, giving in detail the items which make up the cost of producing cotton and the relation which this enterprise bears to the rest of the farm business.

FARM WOODLOT.—The investigation on the economics of the farm woodlot has been carried on in the Eastern and Southeastern States in cooperation with the Forest Service. Sixteen areas have been visited, in each of which 50 to 75 farms have been studied.

FARM-MANAGEMENT SURVEYS.

The investigations by farm-management surveys include studies of the farmer's investment, receipts and expenditures, the net income from the farm business, and the important factors which largely control this income. It also includes studies on the relation of tenure, size of business, diversification, and efficiency of the various farm enterprises to profit. Within the past year substantial progress has been made in the analysis of several thousand farms in Pennsylvania, Michigan, Indiana, Utah, Ohio, and Georgia. Special attention has been given to a survey of over 500 farms in Chester County, Pa., an old and well-developed farming district. Results

of this study are published in Department Bulletin 341. An analysis of the agriculture of farms in the cotton-growing States has also been made, and the results have been prepared for publication. The work in Ohio and Indiana, where studies are being made over a period of years in the same areas, has been continued. Four years' records are now available for the Ohio district and three years' records for the Indiana district. Special attention has been given to the determination of factors entering into the cost of the farmer's living and what the farm contributes directly in the form of garden products, milk, butter, eggs, etc. Farmers' Bulletin 635 has been issued, and another manuscript has been prepared for publication.

Analyses have also been made of several hundred farms in agricultural districts where tenant farming is of primary importance. Special attention has been given to a study of the underlying principles of lease contracts and the effect of the various features of each system of tenancy upon the income received by tenant and landlord. A study of the tenant systems of farming in the Yazoo-Mississippi Delta, also a study of systems of renting truck farms in southwestern New Jersey, have been published.

FARM ACCOUNTS.

The studies of the various systems of bookkeeping as worked out by farmers and other individuals interested in this line of research have been continued. Additional information regarding the practicability of certain of these systems has been compiled, and two manuscripts are in course of preparation.

FARM EQUIPMENT.

The investigations on this subject have been confined to studies of the character, cost, and adequacy of farm equipment in machinery, implements, etc., with reference to farms of different types and sizes in different sections of the country. A large amount of data has been collected dealing with the farmers' experience with the various items of farm equipment, and these results have been compiled for publication. Three bulletins dealing with the economic features of equipment have been issued within the past year. These are Department Bulletins 321 and 338 and Farmers' Bulletin 719. One other manuscript has been prepared for publication. In studies on the equipment of truck farms and greenhouses much valuable data has been secured. Special attention was given to systems of heating greenhouses and the various factors affecting the cost of same.

HISTORY AND DISTRIBUTION OF FARM ENTERPRISES.

Substantial progress has been made in the studies on the history and distribution of various crops and types of live stock in this country. Large masses of geographic and statistical data have been compiled for use in connection with an Atlas of American Agriculture and an Atlas of World Agriculture. These data have been collected from the various governmental agencies both in this department and in other departments in Washington. Cooperation

has been effected with other bureaus of the department, with a large number of State colleges and experiment stations, and with other institutions which are in a position to contribute information of use in the preparation of the Atlas of American Agriculture. A graphic summary of American agriculture was published in the 1915 Year-book.

SPECIFIC ORGANIZATION PROBLEMS.

Work in this section during the past year has been about equally divided between field studies on the one hand, and tabulating and interpreting field data and the preparations of manuscripts on the other. The accumulation and interpretation of a vast array of facts with reference to the different ways the farmers of the country have organized their business and the degree of success which has attended these different types of organization have led to a clearer insight into the organization problems of the farmers and to a greater knowledge of how to solve these problems successfully.

For convenience of administration this work has been divided into four geographical regions, as follows: Northeastern States, Southern States, North Central States, and Western States.

NORTHEASTERN STATES.

During the first half of the fiscal year 1915 the work in the New England States consisted largely of field work and marked the completion of a survey begun during the previous year and designed to furnish a general view of the agriculture of these States. This survey consisted of about 1,900 complete farm analyses or records for one year's business, comprising 21 separate areas in New England. These areas were selected, so far as possible, both in southern and in northern New England, including all the more general types of farming but excluding the more specialized types such as are found in the lower Connecticut Valley, where tobacco and onion growing predominate, and the specialized poultry farming in the vicinity of Long Island Sound.

The purpose of this work has been to discover and work out by the study of these farm records the most profitable organization for each of the various types of farming included in the survey. To this end and to supplement the complete farm analyses, enterprise records were also taken in each of the more important areas. These records show the amount of labor normally required and the season of performing each operation for each of the more important farm enterprises. In addition they show the relative cost of conducting the various enterprises making up the farm unit.

Since completing the field work the remainder of the fiscal year has been devoted to working up the survey, compiling the data contained therein, and interpreting and getting the results ready for publication. This study is designed to show the most profitable organization for each type of farming as found adapted to the various areas, as well as the broad principles entering into and contributing to the success of this organization.

During the first half of the fiscal year a farm-management survey was made in a representative commercial trucking region in Glou-

chester County, N. J. This survey included about 250 complete farm records, with a large number of enterprise records to supplement. During the latter half of the year this survey was retaken, obtaining records on the same farms for another business year and extending the boundaries of the area to include about 100 more complete farm analyses. Three years' records in this region are deemed advisable before attempting to draw conclusions as to the most profitable organization, because of the wide fluctuation in yields and prices from year to year with this kind of farming. This survey when completed will furnish data for a detailed study of the organization and other problems confronting the commercial truck grower.

Records were also obtained from 100 or more farms in Mercer County, N. J. Truck growing is practiced here, but is of a different type from that practiced in Gloucester County, truck crops being raised on a smaller scale and for the retail trade.

Carrying still further the work done in Chester County, Pa., a study has been made of the organization of a number of successful dairy farms. Complete farm-survey records have been taken, with dairy enterprise records to supplement.

Study has been continued on the system of management on a large dairy farm in New Jersey. On this farm alfalfa is now grown to the extent of about 500 acres. A great part of the previously expensive grain ration for a large dairy herd is replaced by this crop, while cash sales add substantially to the farm revenue. This farm is working out many interesting practical problems both in farm practice and in combining the various crop and live-stock enterprises into a smooth operating unit. The study is of particular value in showing how it is feasible to grow alfalfa to such a large extent, in connection with general and dairy farming, without upsetting the organization of the farm.

In Bradford County, Pa., an extended study has been made of farm organization and farm practice with a view to working out profitable types of farming under conditions which are normally somewhat adverse to best results. In this region there are large numbers of poor-land farms, with little but labor available for their development. The organization problem here is one largely of expediency, as well as of efficiency. The farmer with limited means and poor land is interested only in what is best to do with what he has at hand. In this area careful business study has been made of about 300 farms. In addition, the investigator has, by a full season's contact on the farms, become thoroughly conversant with the many problems presented.

SOUTHERN STATES.

The field work in this section during the past year has been conducted as follows:

In West Virginia 500 farm-survey records were taken in Greenbrier, Monroe, and Upshur Counties, in cooperation with the University of West Virginia. In Christian County, Ky., and Montgomery County, Tenn., 350 farm records were taken. These studies were supplemented by over 300 farm-enterprise and cost records. A tabulation of 200 farm records and 100 enterprise records taken in the blue-grass region of Kentucky has been made. Similar studies have been made in Jefferson County, Ky.

Two hundred farm-survey records have been taken in Frederick County, Md., and a study of the data will shortly be offered for publication. A field study has been made in Albemarle County, Va., in cooperation with the office of Rural Organization.

A tabulation of the survey data secured in 1914-15 in the north Piedmont section of Virginia has been practically completed.

Studies of a large group of farms in Catawba County, N. C., begun several years ago, have been continued. This study is of particular interest in that it brings out the facts with reference to the relative profits from crop farming versus live-stock farming in a region of the South where a large number of both types of farms are found.

In South Carolina an extensive study has been undertaken of farm-organization and farm-management problems in the Norfolk sandy loam soils of Orangeburg County. The greater part of the time in this region has been spent in tabulating and interpreting the records taken the previous year in Anderson County, S. C.

In Georgia the extended study undertaken last year in Brooks County has been completed.

In Alabama and Mississippi the past year has been devoted largely to completing the study of the data secured in the cost of production survey in Coahoma County, Miss. A study has also been made on the cost of establishing the Satsuma and other citrus orchards on the Gulf Coast.

In Texas a study undertaken last year in the lower Rio Grande trucking section has been completed. A survey was made during the year in Ellis County, Tex.

In Arkansas and Louisiana extended studies have been made in farm practice in harvesting corn and bur-clover seed and in growing lespedeza. A method has also been worked out for hastening the germination of bur clover by boiling the burs which contain the seed.

In Oklahoma field studies of two areas have been completed during the year. These studies were made in cooperation with the College of Agriculture, one of them in the region surrounding the college and the other in west-central Oklahoma. Records from field studies made in north-central Oklahoma and south-central Kansas taken the previous fiscal year have been checked and tabulated.

NORTH CENTRAL STATES.

In the North Central States field survey studies have been made during the past year as follows:

In the northern cut-over districts of Michigan, Wisconsin, and Minnesota on 800 farms; in the muck regions of southern Michigan and northern Indiana, 100 farms. These survey studies have been supplemented by enterprise surveys on 100 farms in Lenawee County, Mich., 25 farms in the northern cut-over district, 25 farms in southeastern Missouri, and 100 farms in the muck-land district of southern Michigan and northern Indiana. A bulletin dealing with the management of muck-land farms in northern Indiana and southern Michigan has been published.

An extensive study has been made of the problems of the cut-over lands of Michigan, Wisconsin, and Minnesota. In this study it is shown quite conclusively that the small farm under the present eco-

economic conditions has not a very large place in the agriculture of this region. In addition to this important finding with reference to a region where the tendency has been to sell in small tracts, the study also brings out many valuable points concerning the management and organization of the types of farming which now prevail in this section.

During the past year a study has been made of alfalfa in the western part of the corn belt. Alfalfa seems from an agronomic standpoint extremely well adapted to this section of the country, and it is gradually finding a place in the cropping system on the farms. There are, however, important problems of how to modify the present systems in order to make them best fit in with this new crop. There is the problem of what old crop or crops it shall supplant and the extent to which it is feasible to grow this crop without bringing too much rush of work at one season with nothing to do at other seasons. The development of a profitable, feasible farm organization is here of far more importance than a mere knowledge of how to make the alfalfa grow successfully.

Investigation has been continued in connection with the sandy-land problem of northern Indiana and southern Michigan. Farmers' Bulletin 716, dealing with the particular problems of this region, has been published. Farm-organization problems in this, as in many other poor-land regions of the country, involve questions of expediency quite as much as of economics. The poor-land farmer wants to know what is best to do with what he already has. Studies in this region have been made with this point in mind.

Attention has been given during the past year to farm-organization problems in southern Indiana and southern Illinois.

The North Central States constitute the great live-stock section of the country. In this section estimates were secured from 7,000 breeders concerning the influence of age on the value of live stock. These estimates have been classified, tabulated, and the results published as Department Bulletin 413.

WESTERN STATES.

The field studies in progress last year in Washington, Oregon, and Arizona have been completed. It is expected that the results of this work will show what types of farming have proved to be profitable in these regions and the conditions under which each type is most successful. These will also show the farmer's investment in land and equipment, his receipts, expenses, and net income on the various types of farms.

The reconnoissance work in the citrus belt of southern California has not yet been completed, but valuable information has already been obtained relative to the business side of the citrus industry.

Further studies have also been made during the past year in the irrigated sections of the West, particularly in Salt Lake Valley, Utah, in the Billings-Huntley project in Montana, the Hood River Valley, Oregon, and the Yakima, Spokane, and Walla Walla Valleys in Washington. These studies will cover much the same points as those already mentioned in Oregon, Washington, and Arizona, the object being to determine the facts regarding investment, receipts,

expenses, types of farming, and size of farms necessary to success in these sections.

FARM PRACTICE IN ITS RELATION TO CROP YIELD.

Data on factors affecting crop yield have been collected on more than 1,500 farms, 448 farms having been studied during the past year. Material is also being gathered from the regular farm-management surveys regarding certain features of the work. Circular 57 of the Office of the Secretary, entitled "The Influence of Relative Area in Intertilled and Other Classes of Crops on Crop Yields," has been published.

LOGGED-OFF LANDS.

Studies relating to methods of clearing land for agricultural purposes have been about completed. The problems remaining relate to the testing of new appliances for work of this kind which occasionally appear on the market. During the past year the phase of the subject which has been under investigation relates to the economic conditions under which commercial removal of stumps is practicable and those under which work of this character must be left to those who are willing to make some financial sacrifice as a means of gaining a foothold on the land. The studies indicate that the original forests which covered much of the good agricultural land of this country have been, in the main, removed at an expense out of proportion to the immediate economic results. But the economic loss appears to have been balanced by other advantages, for the sacrifices thus made enabled an army of men with their families to acquire economic independence. It appears that under the conditions which prevail in most localities where the problems of clearing land is a serious one, the land must in the main be cleared by its owners at a financial sacrifice, the financial loss being balanced by less tangible advantages.

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